VOLUME 4, NO. 1 JANUARY 1949

MAPPABLE CHARACTERISTICS OF FOREST SOILS ..... Herbert A. Lunt and C. L. W. Swanson

THE MUSKINGUM STORY ..... Bryce Browning

ECONOMIC ASPECTS OF SOIL CONSERVATION PROBLEMS ..... William G. Murray, Earl O. Heady and John F. Timmons

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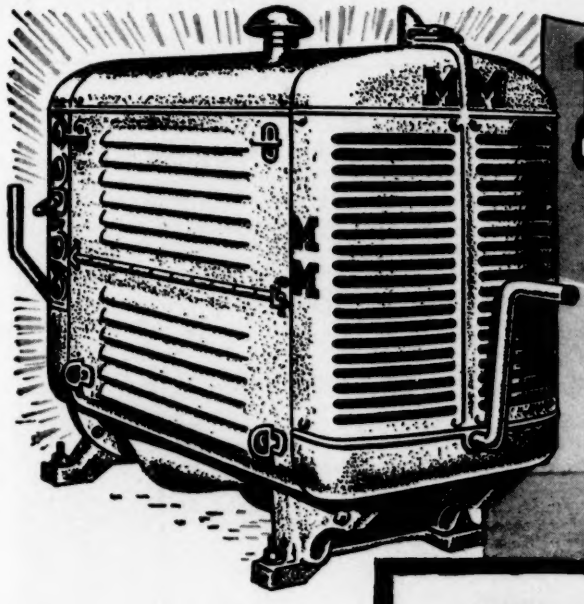

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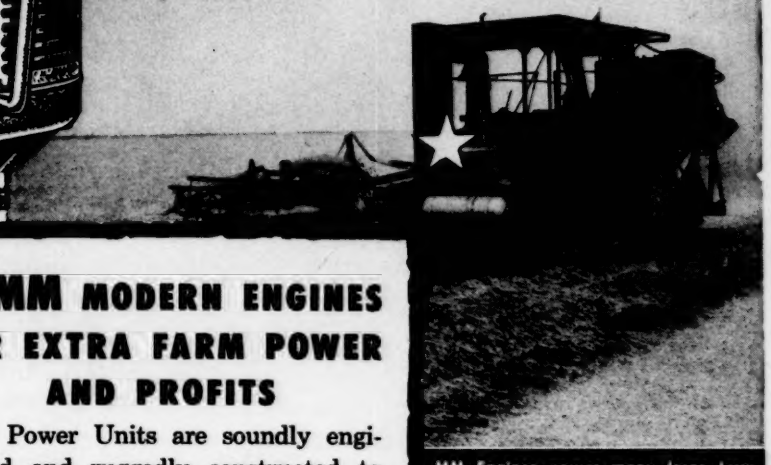

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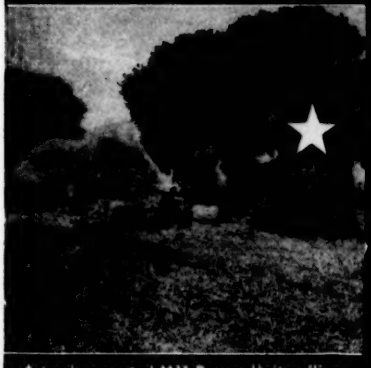

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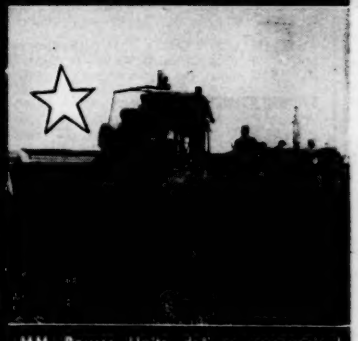

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VOLUME 4
NUMBER 1

Journal of SOIL AND WATER CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SOCIETY OF AMERICA

This JOURNAL is owned, edited, and published quarterly by the Soil Conservation Society of America.

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PUBLICATION OFFICE: 32nd Street and Elm Avenue, Baltimore 11, Maryland.

NATIONAL HEADQUARTERS AND SECRETARY'S OFFICE: Box 1409, Spartanburg, South Carolina.

POST OFFICE ENTRY: Entered as Second-Class matter in the Post Office at Baltimore, Maryland, August 28, 1946, under the Act of March 3, 1879.

MEMBERSHIP: Annual membership is on a calendar year and is $3.00 per year of which $1.50 is for subscription to the JOURNAL and .25 cents for NOTES AND ACTIVITIES. Subscription for the JOURNAL to Libraries and others is $3.00 per year. Single copies are 75 cents each.

CORRESPONDENCE—Concerning manuscripts, books for review and other editorial matters should be sent to the Editor, Room 303, Bethlehem Building, Fairmont, West Virginia.

BUSINESS CORRESPONDENCE—Concerning remittances and questions should be sent to the Secretary, Box 1409, Spartanburg, South Carolina.

CHANGE OF ADDRESS: Notice of change in address should be received two weeks before the date of issue on which the change is to take effect. Both the old and the new address should be sent to the office of the Secretary.

REPRINTS: Articles appearing in this publication may be reprinted on condition that full credit be given the JOURNAL OF SOIL AND WATER CONSERVATION and the author; also the date of publication.

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National Land Policy

The conservation and wise utilization of natural resources is fundamental to the economic and social welfare of all people.

Land, including soil, water and the dependent living resources, (cultivated crops, forests, wildlife, range lands, etc.) is recognized as basic wealth and it must be treated in such a way that it will be made secure for permanent high productivity.

It is essential, therefore, that a National Land Policy be developed and supported by the American people, and the Soil Conservation Society of America recommends that such a policy be:

All Land Should Be Used in a Manner Which Will Insure Its Continued and Permanent Maximum Productivity and Values

To adopt and effect such a policy, the following requirements must be recognized nationally:

- The conservation of soil, water and interdependent renewable resources involves scientific study and guidance, necessitating the bringing together as a single function many facets of a vast number of scientific fields. Therefore, the science of soil and water conservation is intricate and complex.
- An inventory of all physical land resources and their condition is of primary importance to serve as the proper guide to the utilization and treatment of these resources.
- Specifically the widespread adoption of a sound land policy should comprehend the need for conservation, development and utilization of land and water resources for: (1) sustained and improved agricultural production, (2) forest protection, re-growth and sustained yield, (3) prevention of erosion and flood damages to safeguard land from overflow and siltation, (4) protection of community and industrial water supplies, (5) maintenance of underground water sources, (6) development and installation of irrigation and drainage as needed to extend appropriate land use and conservation, (7) protection and maintenance of fish and wildlife in accordance with proper land use, (8) development and utilization of areas most appropriately suited for needed recreationly purposes, and (9) protection, and in certain cases, revegetation of areas suited to range utilization.
- The ultimate goal in land use is a complete soil and water conservation program on every farm, ranch, forest, and watershed throughout the country.

To functionalize the above land policy and the specific principles involved, the Soil Conservation Society of America recognizes that:

- The conservation of soil and water by efforts of the individual land-owners and operators is the most important contribution that can be made to the carrying out of this land policy. Locally and democratically organized groups of land-owners and users are the best known vehicles for carrying out soil and water conservation programs designed to improve and perpetuate the productivity of our basic natural wealth—the land.
- Private ownership of land is, for the most part, the most suitable system under which a *National Land Policy* can be effective. It is recognized, however, that good management, public interest and welfare necessitate public ownership and administration of certain land areas.
- The technical, educational, financial and other services necessary to the adoption of a fully coordinated land-use program should be thoroughly integrated and cooperatively performed, to carry out this land policy and all its principles.
- Private, corporate, and allied groups have a major responsibility in obtaining adoption of this land policy and in the conservation of soil and water.
- A workable method of carrying out coordinated programs of land use, soil and water conservation requires the joint and cooperative efforts of the federal, state and local governments which are, or may become, engaged in these endeavors. It is also necessary that the administrative forces charged with such activities be given explicit responsibilities for contributions to such coordinated programs.

In a great measure, our national economy, our democratic process and our national security are dependent on the future conservation and use of our basic natural resources. These proposals are therefore made in the interest of the public health, safety and general welfare of all the American people.

The above resolution was approved at the Third Annual Meeting of the Soil Conservation Society of America, held at Cincinnati, Ohio, December 9, 10 and 11, 1948—*Editor.*

Mappable Characteristics of Forest Soils

HERBERT A. LUNT and C. L. W. SWANSON

Soils in forested areas previously given little consideration are now beginning to receive the attention they deserve. This paper points out that the mapping of soil characteristics significant in tree growth and stand composition is practical and should be properly related to forest type maps. It also describes a mapping legend for Connecticut forest soils.

SOIL SURVEYING IN FORESTED areas has generally lagged far behind the mapping of agricultural soils. There are several good reasons for this. From the beginning of settlement farm land has had a higher economic value and the need for information on farm soils was great. Where precipitation is sufficient, trees grow on almost any soil without special treatment, and it is the usual practice to relegate trees to all land not suitable for other uses. Hence it was natural to pay but slight attention to forest soils.

Fortunately the picture is changing. Soil scientists are learning that "rough stony land" is a very inadequate description of soils. Foresters have come to realize that *trees grow in soil* and that *not all soils are alike*. Even in the Pacific Northwest forest soils can no longer be ignored now that virgin timber is disappearing and second growth stands are beginning to take its place. At a forest soils conference held in Portland, Oregon, last September it was agreed that the setting up of a soil survey program for forest land was first in importance in the Douglas fir region.

The interdependability of the forest type map and the soil map is being recognized. In the words of Wilde (11) "It (the survey of forest land) defines the areas adapted to silviculture or other uses, and delineates the soils suitable for planting to different tree species or for loging by different cutting methods. It forms the basis for the construction of yield tables, calculation of the annual cut, and determination of expected financial returns. Moreover, soil survey often proves invaluable in the appraisal of land for sale or exchange, taxation, and settlement of damage suits." To these uses of soil maps we can add flood control, water storage, erosion, recreation, highway engineering, building construction, and geology. The role of soil maps in helping foresters to evaluate the potential timber producing capacity of open land should not be overlooked.

Soil Classification and Mapping (General)

Unfortunately soil mapping cannot be done in the office from aerial photographs although such photographs are helpful, especially in the case of bare land and freshly plowed fields. It is necessary to traverse the ground and examine the profile frequently.

The chief factors which influence the character of the profile are geologic origin and kind of parent material, climate and vegetation, topography and drainage, and the length of time these factors have been operating. The soil characteristics looked for include texture, color, consistence, structure, thickness, and reaction (pH), of each horizon. All soils with similar characteristics are assigned a series name which, together with the texture of the top soil, constitutes the soil type name. Thus we have Brookfield fine sandy loam, Brookfield stony fine sandy loam, Brookfield loam, Merrimac loamy sand, Merrimac loam, etc.

The series found in a given area, i.e., southern New England, are tabulated according to outstanding soil characteristics and kinds of parent material, and then by drainage classes. This tabulation, called a catena[1] key, is an invaluable aid in the making and interpreting

[1]Catena—from the Latin meaning a chain. The term was proposed by Milne as "a unit of mapping convenience," and defined as "a grouping of soils which, while they fall wide apart in a natural system of classification on account of fundamental genetic and morphological differences, are yet linked in their occurrence by conditions of topography and are repeated in the same relationships to each other wherever the same conditions are met with." (9)

Drs. Herbert A. Lunt and C. L. W. Swanson presented this paper at the National Meeting of the *Society of American Foresters*, Boston, Massachusetts, December 16-18, 1948.

The authors are connected with the Connecticut Agricultural Experiment Station, New Haven, Connecticut. Dr. Lunt is an Associate in Forest Soils and is recognized as one of the first soil scientists of this country to make a study of forest soils. Recently he was made Chairman of a newly organized Forest Soil Classification Committee in the Forest Soils Subsection of the Soil Science Society of America.

Dr. Swanson is Chief Soil Scientist for the Connecticut Station. He too, has been active in the classification of soils in his home state and elsewhere. Dr. Swanson is the author of an article entitled "Land Use and Soil Conservation in Japan," which appeared in the last issue of the JOURNAL—VOLUME 3, No. 4.

The contribution of G. A. Bourbeau, Norman E. Hawes, Henry Hicock, N. Holowaychuk, H. A. McKusick, and G. A. Quakenbush to this paper are acknowledged by the authors.

TABLE 1. ABRIDGED CATENA KEY OF SOME NORTHEASTERN SOILS

Drainage:		Excessively drained	Excessively to well drained	Well drained	Moderately well drained	Poorly drained	Very poorly drained
		Deep	Shallow		Normal to deep		
Parent Material	Profile features:	Coarse textured B and C	30" to bedrock	Free of mottling	Mottled in lower B and C	Mottled in lower A, & in CG[1]	Dark surface; gray CG[1]
UPLAND SOILS DERIVED FROM GLACIAL TILL, UNSTRATIFIED							
Noncalcareous							
Granite & granite gneiss; loose to friable till	1		Shapleigh	Goucester	Acton	Leicester	Whitman
Compact till	2			Essex	Candia	Ridgebury	Whitman
Gray mica quartz schist; firm till	3		Hollis	Charlton	Sutton	Leicester	Whitman
Compact till	4			Paxton	Woodbridge	Ridgebury	Whitman
Triassic red sandstone & shale; friable till	5		Sunderland[2]	Cheshire	Ludlow	Wilbraham[2]	Menlo[2]
Compact till	6			Wethersfield	Ludlow (cpt.)	Wilbraham	Menlo
Gray Devonian sandstone & shale, friable till	7		Lordstown	Wooster			Chippewa
Compact till	8			Otsego	Canfield	Wolusia	Chippewa
Calcareous							
Limestone, some schist, shale, slate & sandstone	9		Farmington	Pittsfield	Amenia	Kandaia	Lyons
Crystalline limestone (marble)	10		Wingdale	Dover	Amenia	Kandaia	Lyons
SOILS OF THE GLACIOFLUVIAL DEPOSITS (GLACIAL OUTWASH PLAINS AND TERRACES) STRATIFIED, WITH GRAVELLY SUBSTRATUM							
Granite gneiss and schist	11	Hinckley		Merrimac	Sudbury	Walpole	Scarboro
Triassic red shale and sandstone	12	Manchester		Hartford	Ellington	Meriden	Scarboro
SOILS OF THE GLACIOLACUSTRINE DEPOSITS							
Reddish-brown silts & clays from Triassic matrl.	13			Berlin	Whippany	Parsipanny	Rahway
Olive, neut. to med. acid silt & clay deposits	14			Suffield	Buxton	Scantic	Biddeford
SOILS OF THE STREAM TERRACE DEPOSITS DEEP SANDS							
Gray mica schist, granite & gneiss, deep sands	15			Agawam			
Limestone, granite and schist, deep sands	16			Burdick[2]			
SOILS OF THE RECENT FLOOD PLAIN DEPOSITS (BOTTOMLANDS)							
Granite, gneiss & gray mica schist	17			Ondawa	Podunk	Rumney	Saco
Triassic sandstone and shale	18			Newfield	Cromwell	Middlefield	Chalker
SOILS OF COSTAL PLAIN SEDIMENTS							
Medium textured,over gravel	19	Wayside		Sassafras	Woodstown	Fallsington	Pocomoke
Medium green sand	20	Colts Neck		Collington	Adelphia	Shrewsburg	Keansburg
SOILS OF THE PIEDMONT RESIDUAL UPLANDS							
Sandstone, shale and slate	21		Penn	Bucks	Readington	Croton	Stanton
Greenstone, schist, & quartzite	22			Adamstown	Roddy	Rohrersville	

[1]Glei layer. In most soils the material is bluish gray or olive gray.
[2]These are field names and have not yet been correlated.

of soil maps because it shows the relationships of one soil to another. A sample catena key, very much abbreviated to save space, is shown in Table 1.

In addition to identifying the soil type, soil surveyors usually record slope, relative degree of erosion, and land use. Nowadays mapping is commonly done directly on aerial photographs on a scale of four inches to the mile. The completed soil maps are published in colors, usually on a scale of one or two inches to the mile (Figures 1 and 2).

Mapping technics suitable for the soils in agricultural areas require critical appraisal before being applied to forest land. Detailed surveying of soils is costly, particularly in areas of rugged topography; while on the other hand too broad a generalization may be wasted effort. It is necessary to know, first, what soil or soil-site factors are important to forestry, and then to determine how the mapping is to be done.

Soil-Site Factors Important in Forestry

The literature bearing on the relation between soil characteristics and site quality of timber stands or success of plantations is sufficiently extensive to preclude its review here. Good discussions are to be found in forest soil text books (8, 11). Space will permit only a few observations.

As indicated previously the *soil type* is the expression of the sum total of the known factors affecting soil development and is the basic mapping unit. Morphology rather than use is the basis of separation. Unfortunately attempts to find a correlation between single soil types as such and site quality have not generally

been successful (5, 7). This is due to several factors.

First, the characteristics which distinguish one soil type from another are not all equally significant biologically. This is particularly true with trees which are slower growing than agricultural crops, and soil differences that would reflect differences in crops may not be readily reflected in tree growth. A grouping of those soil types with similar properties affecting growth would seem to be the answer, but the basis of such grouping will vary with soil and climatic conditions and must be determined through research and experience.

The second factor is clearly stated by Lutz and Chandler (8) thus: "Soil classification and site classification are not synonymous, for the reason that site is determined by the integrated influence of *all* the factors of the environment, of which soil, although highly important, is only one." Apparently what is needed, therefore, is a modification of soil maps to include some of these other factors of site. These will be discussed in subsequent sections.

Numerous attempts have been made to find one or two specific measurable soil characteristics (without regard to soil types as such) that would serve as an indicator of site quality, or of stand composition, or of some other characteristic of a forest stand. Various investigators have attained some measure of success in certain localities, with certain species, and under certain conditions, with one or more of the following soil qualities:

Texture and thickness of the A horizon.

Figure 1. Soil map of a small portion of Grafton County, New Hampshire (6). The upper right portion is an example of reconnaissance mapping; the upper left section is semi-detailed, and the center and lower portion, detailed. (1 inch on scale shown equals 1 mile.)

Legend: Af—Agawam fsl; Bt—Becket st l; Ca—Canaan l; Cd—Canaan st l; Gl—Gloucester st fsl; Hg—Hinckley g fsl; Hr—Hermon st sl; Mc-Merrimac ls; Ms—Merrimac sl; Os—Ondawa fsl; Pf—Podunk fsl; R—rock outcrop; Rm—rough mountainous land; RsC—rough stony land, Canaan soil material; RsG—rough stony land, Gloucester soil material; Wh—Whitman l; Wo—Whitman st l.

fsl—fine sandy loam	st—stony
g—gravelly	ls—loamy sand
l—loam	sl—sandy loam

Nitrogen content of the A horizon.
Depth of incorporation of organic matter.
Depth of the solum (A and B horizons).
Permeability, structure, and consistency of the B horizon.
Silt plus clay content of the A and B horizons.
Presence or absence of a calcareous horizon and the degree of erosion.
Character of the C or parent material.
Percentage of silt plus clay in the B divided by the depth of the B in inches.

Manifestly none of the foregoing relationships are universally applicable in all climates and under all conditions. In an area of preponderantly heavy soils (silty clay loams to clays), for example, impermeability of the subsoil is detrimental to tree growth, while in sections of light soils, as in southern New England, a moderate impermeability is an asset. Any measurable factor that works, even though limited to a certain area or under

Figure 2. Soil map of a small portion of Missisquoi County, Quebec (1). (1 inch on scale shown on extreme right equals 1 mile.)

Mapping symbol: $\frac{\text{Soil series—texture}}{\text{stoniness—topography}}$

Legend, *soil types:* Bl.l—Blanford l; Blshl—Blanford l, shallow phase; Brgl—Brompton gl; Brl—Brompton l; Fsl—St. Francis sl; Kgsl—Knowlton g sl; Msil—Milby si l; Pel—Peru l; Rgl—Rougemont gl; RS—rough stony land; Shsl—Sheldon sl; Sl—Shefford shaly l; Wol—Woodbridge l; Ua—alluvial, undifferentiated. (si l—silt loam.)
Complexes: H-Bd—Henryville-Bedford; Mi-S—Milton-Shefford.

Stoniness:
0—stone free
1—occasional stones
2—stones numerous
3—stones numerous, many boulders
4—too stony for cultivation
5—rough and stony land; outcrops of bedrock
√√—rock outcrop

Topography:
0—level to gently undulating
1—gently undulating to undulating
2—undulating to rolling
2a—kamey
3—rolling to hilly
4—hilly
5—mountainous

certain conditions, is worth considering. Eventually it may be correlated with soil type or at least be a factor that should be recognized in the mapping of forest soils in that area.

Morphological Description Favored

Wilde (11) claims that the use of the conventional soil type legend results in a map that "cannot be interpreted without an accompanying report, and is inconvenient in the field." For these reasons, according to him, such maps have never been popular with practical foresters. Instead he favors the use of morphological descriptions such as barren sand, leached sand, outwash mull loam, moranic loam podzol, wet loam, mottled loam, structural clay, etc. In areas having a great diversity of soil types "nomenclature often involves a combination of textural, genetical, geological and hydrological characteristics."

Systems similar to the above are in common use in Europe. The advantage of simplicity is offset by several serious objections. One is that the types recognized are not sufficiently well defined nor are they based on comparable soil profile characteristics. In one case the basis of separation is geologic origin, in another—moisture, in another—soil structure, and so on. Obviously an explanatory report would be just as necessary here as where the mapping is based on soil series and type.

A second and more serious objection is that the system bears no relation to the well established and widely used (in the United States) soil classification scheme as set up by the U.S.D.A. Division of Soil Survey. So far as soils are concerned foresters would be talking a different language than agricultural people. The use of several different systems would greatly lessen the value of each.

For mapping extensive areas of wildlands, Colman (2) has suggested a broad generalization of the soils legend, basing separations on geology and texture, with due consideration of topography, soil depth and profile development. Maps of this nature are useful for the purposes for which they are made and they fit into the conventional soil classification scheme. The chief danger is one of over-generalization and limited use. To be of value in forest management, specific areas would require maps showing more detail than those proposed by Colman.

Very recently Hill et al (5) report a scheme for grouping soil types into what might be called "profile types" but which the authors call mapping units. The basis of this grouping is texture of the surface soil. premeability or texture of the subsoil, and character of the substratum. The advantage of the plan. which is patterned after the mapping units set up by the Soil Conservation Service for farm planning, is that it is a grouping based on the conventional soil classification scheme, hence does not require a separate legend. It was found that site quality of existing Douglas fir stands in Lewis County, Washington, was rather closely correlated with the proposed soil units, and further, that from the "profile type" map it is possible to predict Douglas fir production for any field or woodlot in the area.

In the case of plot work, the maximum detail may be required. Not only the soil type on each plot must be known but specific descriptions of the texture, depth and other properties of each horizon, and possibly certain physical and chemical analyses may be necessary. Such analyses are in the category of research in which the ultimate aim is to place greater dependence upon mappable characteristics.

Slope and Aspect. The importance of slope and aspect in forestry are too well known to require elucidation here. Where a topographic map is used as the base map both slope and aspect are clearly shown. Also they can be ascertained in many instances on aerial photos by means of a steroscope. Where neither are available, slope and aspect should be indicated if at all possible. The senior suthor has on occasion used short arrows to indicate the direction of down slopes, with the relative steepness shown by variations in the width of the arrows, thus: B slope ↓ , C slope ↓ , DEF slopes ⇓. The latter is unnecessary, of course, if slope is included in the mapping unit, as described later.

Moisture Relations. Closely associated with and largely dependent upon slope and aspect is another factor—moisture relations (aside from drainage). One need not search far to find situations in which, owing to topographic position, growing conditions are better in one location than another on the same soil type. Slope and aspect alone, however, are not necessarily indicative, for moisture relations frequently depend upon adjoining topography. The inability of the usual soil map to show these detailed differences in site on well-drained and moderately well-drained soils is one of its chief weaknesses so far as forestry is concerned. Foresters are well aware of such site differences and indicate several of the more extreme conditions by such designations as oak ridge, bottomland hardwoods, and pine barrens. The extremes will usually be shown by the soil type but there has been no way to indicate the intermediate variations which are likewise important.

Wilde (11) mentions the three types of topography proposed by Passage in 1929 via. (a) positive topography—peaks, ridges, hill tops and higher slopes: (b) neutral topography—level or nearly level plains, terraces, etc., and (c) negative topography—lower slopes, valleys, basins, etc. However, aside from dividing slopes

into five different degrees of steepness, Wilde makes no provision in his mapping techniques for showing these several types of topography.

The writers believe they are sufficiently important to be mapped, and propose the following tenative mapping units for moisture relations;

W_1—*Very unfavorable* moisture relations. Oak ridges hill tops where the soil is light, gravelly knolls, and upper slopes of south exposures. In southern New England chestnut oak is frequently the principal hardwood species on these sites, usually associated with other oaks. On sandy or gravelly soils—pitch pine, or red pine (planted).

W_2—*Unfavorable* moisture relations. Somewhat better condition than W_1 but still drier than average. This would include level, sandy and gravelly soils.

W_3—*Medium or average* moisture relations. Level areas of sandy loam or heavier texture without adjoining higher land, middle long slopes, short slopes and undulating topography. These sites contain many species but there is less likelihood of finding those mentioned under W_1 and W_5.

W_4—*Favorable* moisture relations. Lower east, south or west slopes, middle north slopes and level areas with some adjoining higher land. The W_4 destination is also applicable to areas adjacent to but not more than a few feet above lakes and streams.

W_5—*Very favorable* moisture relation. Coves, lower north slopes, and all other well-drained or moderately well-drained sites which support such moisture-requiring trees as white ash, tuliptree (yellow poplar), elm, red maple, and basswood.

It should be emphasized that the field moisture condition at the time of examination should not be the criterion of separation. Rather it is the overall moisture picture throughout the growing season that counts.

Humus Type. A third factor not included on soil maps is the type and thickness of the forest humus, i.e. the F and H, or A_0 layers. Owing to its transitory nature, freshly fallen litter (L) should not be included.

The role of the different types of forest humus as a factor of site quality is not clearly defined in all instances but their importance in regeneration, in nutrition, and in flood control cannot be questioned (7, 8, 11). The significance of mull and mor has been established (3). More extensive mapping of this factor may be fruitful in revealing relationships not now known.

The difficulties involved in mapping humus types are not minimized. In the first place there is a lack of full agreement on the present humus classification (4) although it has been adopted as the best one now available. Agencies having definite need for information on forest humus conditions in flood control and forest influences work have, in some cases at least, found it necessary to simplify the classification. To probe further into the situation in the hopes of developing possibly a more workable system for the Northeast, a group interested in this problem met at Petersham, Mass. last June. Out of that meeting came certain recommendations for modifying the present humus classification for practical field use, and the setting up of a committee whose duties will include revision of definitions where needed and the formulation of a key. (To carry on similar work on a national scale a committee on Forest Soil Classification has been formed in the Forest Soils Subsection of the Soil Science Society of America).

The second difficulty in mapping humus types is the practical one of how to do it. To delineate humus type boundaries in detail is out of the question in most instances because of the variability of humus from spot to spot. The best that can be done is to indicate the average or most prevalent type and thickness for the forest type or for the soil type. Usually the character of the humus is more closely bound up with stand than with soil.

Stoniness is not usually considered to be a factor in forest site quality, although Viro (10) reported a significant inverse correlation. Unless extreme, stoniness may, in fact, be somewhat beneficial to tree growth. However, rock outcrops affect tree anchorage and interfere with planting, and large boulders are a handicap in woods operations.

The older soil maps contained symbols for stony soils, rough stony land, rockland (or scabland), and rock outcrops, with no mention of the kind of soil constituting the rough stony land. More recently as soil surveyors have pushed further into marginal agricultural lands and adjoining hilly areas, they have taken cognizance of the soil material. Figure 3 is an example of semi-detailed mapping of forest land. Soil reports now include besides stony soils, very steep or very stony land (with the principal soil material indicated), rough mountainous land, and rock outcrop. Rough mountainous land is primarily a mapping unit in reconnaissance mapping. In semi-detailed mapping, the less rugged portions of the area would be designated very steep or very stony land consisting of certain soil materials.

The Quebec soil survey has adopted a more complete breakdown, as shown in the legend for Figure 2.

For Connecticut[2] a still different legend for stoniness has been devised, based on the Soil Survey Division's

[2] C. L. W. Swanson, Preliminary soils legend for Connecticut. Conn Agric. Expt. Sta. Special Bul. Soils IV, July 1948. Processed.

nomenclature for coarse fragments in soils.[3] Since this legend is a preliminary one, it can be expected that revisions will be made as additional field work on this problem is done.

It consists of the following separations:

X—stony. Stones<2 feet diam. and 25-100 feet apart

T—very stony. Stones<2 feet diam. and <25 feet apart

B—bouldery. Boulders<2 feet diam. and 25-100 feet apart

Z—very bouldery. Boulders>2 feet diam. and<25 feet apart. (Figure 4).

E—bouldery-stony. Stones and boulders<5 feet apart.

√√—rock outcrop.

L—soil with occasional outcrop (outcrop 100'-150' apart); 10-25% of the area bedrock.

M—soil with frequent outcrop (outcrop >100' apart); 25-50% of the area bedrock.

W—bouldery land with outcrop, variable; 10-50% of the area bedrock.

R—rockland; >50% of the area bedrock.

Field men using this system in the Hartford County (Connecticut) survey seem to find it practicable, and in our detailed-reconnaissance work in State Forests thus far we have used it to advantage. Inasmuch as the soil mapping program is aimed at obtaining basic information useful to many agencies, not all of the information obtained will be needed by foresters. Hence in map-

[3]Report of the committee on nomenclature and definitions of coarse fragments in soils, geological materials, and land forms and soils. Soil Survey Division, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture, July 1947. Mimeographed.

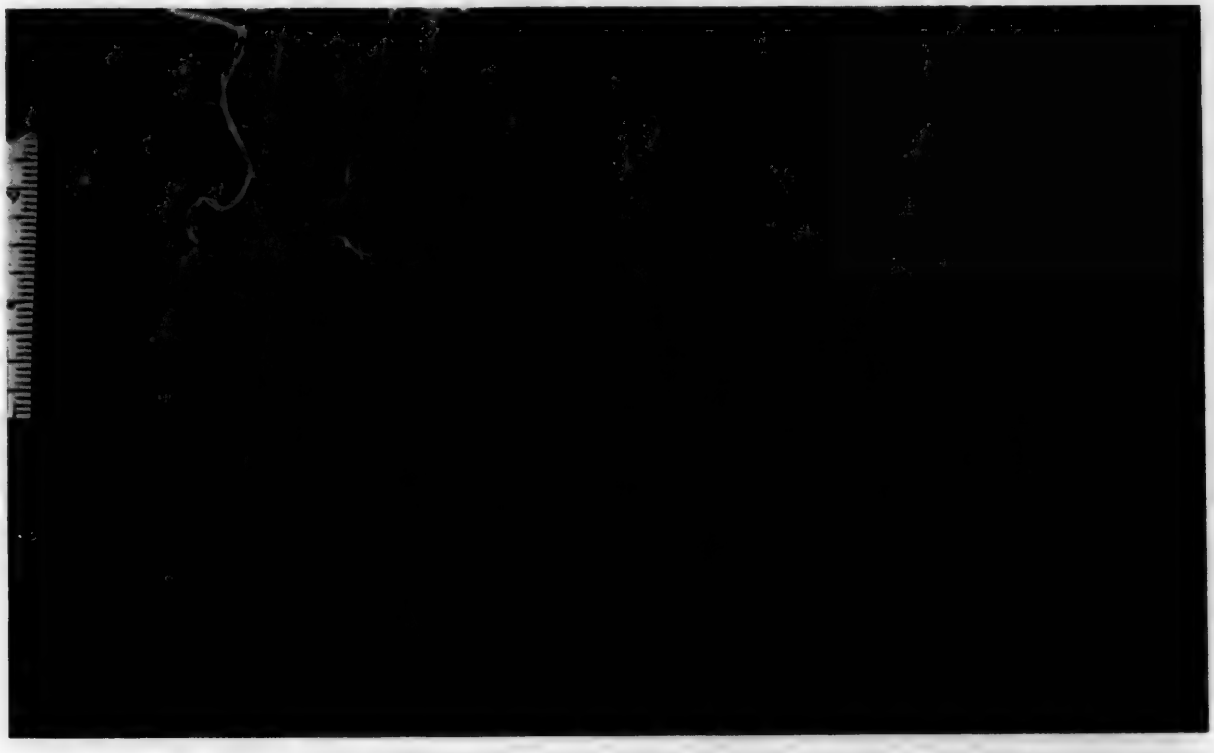

Figure 3.—Semi-detailed map of forest land. The farm land on the left was mapped in detail. A portion of Dutchess County, N. Y., adjoining Kent, Conn. Soil Conservation Service. (1 in ch on scale on extreme left equals approximately 1650 feet). Legend: 59—Lyons st si l; 87—Chatfield st l; 88—rough stony land (Gloucester-Hollis-Chatfield soil materials); 187—Gloucester st l; 294—Carlisle muck; 417—Sutton si l; 421—Whitman st si l; 423—Homer g si l; 424, 425, 426—Genessee fsl; 427—Dover fsl, shallow phase; 429—Pittsfield gl; 433—Gloucester gl; 4320—same as 88.

Slopes:
A—0-3%
B—3-15%
C—15-30%
D—30-50%
E—over 50%

Erosion:
1—little or none
2—moderate
3—severe

ping extensive forested areas it may be sufficient to use only the following: stony, bouldery, soil with rock outcrop (LM), and rockland.

Other separations may be more appropriate in those sections of the country where stoniness is of less consequence than it is here in the Northeast. It is seldom necessary to use all of the separations listed.

Mapping Forested Land

The combination of restricted visibility and rugged terrain characteristic of many forested areas create mapping difficulties not usually encountered in open farm and range land. The desirability of postponing soil mapping in deciduous woods until after leaf-fall is obvious. The amount of detail required depends upon the uses to which the soil map will be put, the time and funds available for the job, and the terrain. Where accurate detail means following compass lines and fighting brush all day, the cost is likely to be prohibitive and seldom justified except in research. On the other hand a too broad generalization results in a soil map of little use to the owner or manager of a particular forest or stand.

It is possible to obtain a reasonably good picture of the soils in a given area by following roads and trails, and making occasional traverses into or across blocks of timber. It would seem that if the expense of forest type mapping is justified, certainly an equally good soil map would warrant the additional cost. This cost can be kept to a minimum if a soils man is added to the forest type—mapping crew so that both jobs can be done simultaneously. The temptation to have one man do both should be avoided for regardless of his qualifications he is apt to show too high a proportion of coinciding boundaries.

The Mapping Legend

The soil mapping unit includes soil type, stoniness, slope and erosion and is usually written in the form of a fraction. Thus in the Connecticut legend $\frac{324X}{B-2}$ refers to Cheshire [32] stony [X] loam [4], with a 3 to 8 percent [B] slope, moderately eroded [2]. For semi-detailed (detailed reconnaissance) maping of forested areas the fraction is written with a broken line and the slope symbols combined. Thus $\frac{135Z}{BC-2}$ indicates that Brookfield bouldery fine sandy loam (Figure 4) is the prevailing soil type but the area so designated may include other series and types, a range in drainage classes and in stoniness and a slope range from 3 to 15 percent. Slopes greater than 15 percent are designated by DEF or DF. However, mappable areas of uniform slope within any one slope class may be designated by the appropriate symbol be it B, C, D or E.

Figure 4. Brookfield very bouldery fine sandy loam; thin fibrous mor and favorable moisture conditions. Peoples State Forest, Barkhamsted, Conn.

With respect to humus types the recommendations of the Petersham conference call for the recognition of five types, and four degrees of thickness. In Connecticut we are finding this system fairly satisfactory so far, and have set it up as follows, adding a sixth—plantation type—to take care of the poorly humified material characteristic of plantations:

M_c—Crumb or other mull
M_f—Firm mull
R_f—Fibrous mor
R_g—Greasy mor
R_o—Granular and other mors
R_p—Plantation type

Thickness refers to the total thickness of the F and H layers together or to the thickness of the mull layer (depth of granulation and organic matter incorporation). The four classes recognized are:

1—thin,—less than 1"
2—medium,—1-2"
3—thick,—2-4"
4—very thick,—more than 4".

The symbols for moisture relations have already been given. Humus type and thickness and moisture relations are usually shown together as a fraction thus: $\frac{M_{c1}}{W_4}, \frac{R_{f2}}{W_2}, \frac{R_{g4}}{W_3}$, etc., and may be placed on the forest type map or on a separate aerial photo if there is not room on the soil map.

Summary and Conclusions

Soils in forested areas, previously given little consideration by soil surveyor and forester alike, are now beginning to receive the attention they deserve.

(*Continued on page 44*)

The Muskingum Story

BRYCE BROWNING

Watershed Management is the theme of "The Muskingum Story." Floods are controlled and soil and water conservation is being achieved on the upper reaches of the basin. Recreational facilities are also being provided. In addition, the Conservancy District has paid the regular real estate taxes on all its lands from the beginning of the project and has operated since 1939 without tax income of any kind.

THE MUSKINGUM STORY is a modest one. It is a typical story of an American community that recognized its problem and started out to do something about it. It concerns Ohio's largest river, the Muskingum, and the one-fifth of the state's area which it drains. This is in the eastern, hill land section.

Settlement of the region started in 1788 when a band of Revolutionary officers fought their way over the mountains, floated down the Ohio River and landed at the mouth of the Muskingum. There they established the town of Marietta. They found a land of great forests, fertile lands and abundant water. The quantities of fish, fur and game seemed unlimited.

By 1880 the area was largely cleared and floods had become a serious problem. The one in 1884 was called the greatest. But there was an even greater one in 1898 and in 1913 came the greatest of record.

The flood of 1913 was general throughout Ohio. It was the State's greatest single disaster. Some 500 lives were lost and more than three hundred million dollars worth of property was destroyed. Everywhere throughout the State people were saying "This must never happen again." "Floods must be controlled." But it was only at Dayton, in the Miami River Valley, that they really acted. There, within a few weeks after the flood crest had passed, contributions totaling two million dollars were pledged and plans for such control were started.

Beginning of Ohio Conservancy Districts

It was through the efforts of the Dayton people that the Ohio Conservancy Act was written and passed. As floods do not follow existing political boundaries, it was necessary to provide a legal method whereby all the affected people of a Valley might work together for their control. With this accomplished, their District was quickly organized. By 1920 the flood control reservoirs and other improvement works were largely completed. *It was the world's first such project. Since that time the people of the Miami Valley have been free of the fear of disastrous floods.*

But the Muskingum Valley people had a much larger drainage area, only a fraction of the wealth, and but little of the leadership so outstanding in the Miami. It was not until 1927, almost fifteen years after the 1913 flood, that someone in Zanesville, the Valley city most affected by it, suggested that the great floods had been occurring at fourteen or fifteen year intervals and that an even greater one was then due.

Frighten a man sufficiently and he may overcome great obstacles. The same rule seems to work with communities. At least it did at Zanesville. Funds were quickly raised, engineers employed, preliminary plans prepared and an able man secured to assist in selling the program. Through his vision the people began to realize that floods were not the major Valley problem. Gradually, they learned that a large portion of all the five million acres embraced in the Muskingum drainage area were so badly eroded as to make them unfit for normal agricultural use.

In 1930 the Valley suffered its greatest drouth. For months there was no rain. Then came the realization that too little water was an even greater menace than too much.

Plan Was Flexible and Broad in Scope

Out of this combination of experiences came the Muskingum plan. It was a flexible plan but with certain very definite objectives. These major objectives were flood control, water and soil conservation. It was agreed that the people of the Valley should contribute, within their means, to the cost of the project. It was believed that both the State and the Federal government, having a vital interest in such an improvement, should do likewise.

Bryce Browning is Secretary of the Muskingum Conservancy District with headquarters at New Philadelphia, Ohio. He is an outstanding leader in the management of watersheds. Mr. Browning presented this paper at the Annual Meeting of the *Soil Conservation Society of America*, Cincinnati, Ohio, December, 9-11, 1948.

In 1933 came the opportunity. The President, as a means of providing unemployment relief, recommended a great public works program. Within a few hours the Muskingum people were in Washington with detailed plans for such a project. Unlike most such groups, they offered direct help in paying its costs.

Within the following ten months the Federal grant had been secured, the Ohio State Legislature had taken action covering their contribution to the project, and the detailed planning was under way. Having a plan and knowing what they wanted was the secret of this success. Without this plan the limits of time would have prevented the inclusion of the conservation features of the program.

Ohio is a heavily populated State. In her main stream valleys are extensive community, industrial and utility developments. These same valleys have the highest agricultural value. Through this advance study, headwater reservoir sites had been discovered where land values were low, where there was little or no interference with communities or utilities and where it was practical to impound far more water than was necessary for flood control.

By adding a little more land and raising the dams a bit higher than was necessary for flood control, sufficient additional storage was provided for the permanent lakes. This was accomplished without any reduction in the required flood storage.

Today, the major engineering works have long since been completed. A succession of recent floods has demonstrated the effectiveness of the control and justified the financial investment. While we are only well started on the broad conservation program, steady progress is maintained. The explanation of how this is being accomplished is the important part of the Muskingum story.

Leadership Is Provided by Local People

The Ohio Conservancy Act provides that the petition for a District is addressed to the Conservancy Court. This Court includes a county judge, known in Ohio as a Common Pleas Judge, from each of the affected counties. These judges are elected for four-year terms and represent one of our highest types of public servant. As our District includes all or parts of eighteen counties, its Conservancy Court has eighteen members. Upon the creation of a District the Court names a three-member Board of Directors to administer the project. They are at all times responsible to the Court. The Official Plan for a project, the appraisal of resulting benefits, the financing of the program or any modification of the plan must first have the Court's approval.

The Board of Directors named by the Muskingum Conservancy Court were practical business men. With the assistance of their staff, they developed not only an Official Plan for physical improvements, but an operating policy. The basic features of this operating policy are:

1. *That the District would continue to pay the regular real estate taxes on all the lands which it acquired as a means of preventing loss to the existing local agencies of government.*
2. *That as quickly as possible the project would be maintained without tax income of any kind.*
3. *That its improvements would, so far as was humanly practical, be made available to all the people. (In the past the shorelines around Ohio lakes had tended to become the property of a favored few. This was to be prevented.)*
4. *That the Conservancy District would not willingly duplicate the work of any other agency of government. (In other words, that they would not undertake any program of work which an existing agency of government, Federal, State or local, was authorized to do and willing to undertake. It was the Board's belief that their primary job was to provide a master plan and to coordinate the efforts of the various cooperating agencies.)*

All of these basic objectives are being attained. Taking them in their order, *the District has paid the regular real estate taxes on all its lands from the beginning of the project. This has totaled more than a quarter million dollars. Since 1939 it has operated without tax income of any type.*

As a means of making its improvements available to all the people, the District has dedicated to public use the 365 miles of shoreline around its ten permanent lakes. This includes all of the island areas. Of the total acreage of District owned lands surrounding its 16,000 acres of lakes, not more than 20 percent may be used for any commercial recreation purpose. This 20 percent includes all intensive use park areas, organized youth camp sites, club sites, and vacation cabin areas. Of the remaining 80 percent, the greater part is being developed as public use forest park areas. A portion is to be used as farm demonstration units.

District Coordinates Work of Agencies

But the District's greatest accomplishment is in the elimination of duplication. This is the major reason for its financial success. At one time there were more than twenty agencies of Federal and State government actively cooperating with the District in the development and administration of its program. As War conditions threatened, many of these agencies were eliminated. At the present there are ten who continue to cooprate in the program.

Figure 1. This is one of the District's ten lakes. The lakes embrace 16,000 acres and 365 miles of shoreline. They are dedicated to public and commercial recreational uses.

In the Federal field these include the Corps of Engineers, both the operations and research sections of Soil Conservation Service, the Forest Service, the Geological Survey and the Agricultural Extension Service. The State Agencies are the Division of Conservation, the Division of Forestry, the State Highway Department and the Ohio State University. There is time to discuss the work of only a few of them.

Under the direction of the Public Works Administration, the Army Engineers served as the construction agency for the Muskingum project. Some years later Congress adopted a National Flood Control policy and the Army Engineers were made responsible for its administration. With the cooperation of the Conservancy District, legislation was introduced making them responsible for the operation of the District's flood control program. It was specifically provided that this operation should be in accord with the Official Plan of the Conservancy District. Thus, the people of the Valley will always receive the full protection provided in this plan.

The District's 16,000 acres of permanent lakes increased the inland lake area of the State by approximately 50 percent. It has been suggested that the increase in fishing was even greater. The Ohio Division of Conservation is our State Fish and Game Department. At the suggestion of District Officials, the Division contracted to administer the fish and game program on all District waters and lands. Both parties to this agreement seem happy. It was the Division's proposal that they pay an annual rental of $2.50 per acre for the water areas. This is the District's largest single source of income. Members of the Conservation Commission have suggested that the arrangement is a great bargain from their standpoint.

War conditions delayed the development of essential facilities at the various lakes. Despite this fact, there was a total of more than two million visits paid them during both 1947 and 1948. During the war period, National Park Service aided in the making of a survey to determine the recreation value of the Muskingum project. The figure arrived at was $807,000 per year. It should be added that there are more than 5½ million people living within a two hour driving distance of one of the three major lake centers.

In 1946 the Conservancy Court approved an "Official Plan for Parks and Recreation." In 1947 they authorized the District to borrow $600,000 for the carrying out of this program. All of this debt is to be retired out of income from the recreation facilities. This program is moving rather cautiously because of extreme high costs, but one of the major park projects is completed and two others are well advanced. These include bathing beaches and accompanying facilities of bath houses, playgrounds, picnic tables, fireplaces, parking areas, toilets and water supply.

Forest Management Is a Major Activity

But the most significant development is in the field of conservation. While many agencies assisted, the work of Soil Conservation Service is outstanding. It was believed that the most effective District work would be in the field of demonstration. Detailed investigations made by Soil Conservation Service indicated that two-thirds of the 48,000 acres of District owned lands, outside its water areas, were best suited to forestry and a

major reforestation program was undertaken. Of this total, 13,000 acres were already in some state of timber development. *A selective cutting and timber improvement program was developed which represents a net average return to the District of $1,500.00 per month. All the expenses of the forestry program, including the tree planting, are being paid for out of this forest income.*

The District has already planted nearly two million trees. However, there are some 17,000 acres remaining to be planted and plans are being developed to increase this annual planting to one million trees or more.

The forester for the Soil Conservation Service assigned to the District staff is a man of vision. Realizing that the forest program could not serve as a demonstration to the other land owners of the Valley, except as it became economically practical from their standpoint, unusual methods were undertaken and trees are planted on the hill lands. The limited areas of level agricultural lands are needed for food production. The first advance in reforestation was to plant on the contour rather than on straight lines. The next step was the advance preparation of these contours. This is accomplished through the use of a specially designed two-way, two-bottom plow, and the work is completed at least a season in advance of planting. This method increased the speed of hand planting by 50 percent, reduced the losses by an equal amount and seemed to almost double the rate of growth in the early critical period.

But tree planting was still too costly to appeal to an average land owner. This year we paid $1.02 per hour for labor to plant trees. While tree planting machines had been experimented with, they would not work on our rugged slopes. Of necessity, our forester undertook the design of one that would. Under the direction of the agricultural engineers at Ohio State University and with the cooperation of manufacturers of tree planting equipment, the machine was built.

Today, this tree planter is in successful operation. Because of a special design the planter follows the prepared contour strips no matter how sharp the curve. With hydraulic adjustments on the wheels, the machine is always on the level no matter how steep the slope. Any degree of slope greater than 40 percent is too great for the crawler tractor which pulls the planter, so this may be our slope limit.

With the machine, two men can plant approximately 1,000 trees per hour. This might be doubled on smoother areas. The rocks, stumps, roots and other obstacles so prevalent on our lands endanger the operators except at the slower speeds.

Results Are Far Reaching

It seems probable that, in my enthusiasm, I have made our story sound too good. We are a long way from perfection. We still make many mistakes. But progress is being made. Our big job is to set a good example; to encourage the people of the Valley to cooperate with the Soil Conservation Service and the other conserva-

(*Continued on page 20*)

Figure 2. This tree planter was designed and built for the rugged slopes in the Muskingum Conservancy District. Two men operating the machine can plant approximately 1000 trees per hour. This may be doubled on less rugged areas.

Economic Aspects of Soil Conservation Problems

WILLIAM G. MURRAY, EARL O. HEADY
AND JOHN F. TIMMONS

The economics of conservation is a matter of concern to the landlord and tenant, to the individual farmer, and to the public where conservation is unprofitable for individual farmers. Public responsibility is based on the fact that public interest is longer term and more lasting than the interest of individual farmers.

THREE PROBLEM AREAS will be discussed. *First,* the issues faced by landlords and tenants in achieving profitable conservation programs; *second,* general principles an individual farmer should follow in making conservation investments; and *third,* public responsibilities where conservation is unprofitable for individual farmers.

Conservation economics appears in clear outline on a rented farm. Before a tenant and landlord embark on a long range soil conservation program, they may discuss at length the economics of such a program. Each party is naturally concerned over the amount of his contribution and estimated receipts. In particular, the tenant is concerned with the time elapsing before he gets his returns and the claim he may have for unexhausted improvements should the lease terminate.

This element of time provides tenants with an important reason for being slower than owner-operators in long run soil conservation practices. The tenant with his limited capital usually has many competing uses for his funds. Compensation to the tenant for used improvements at the end of a lease is still a complicated device and landlords have not been active in pushing it. The result has been a relatively poor record of conservation on rented farms.

Tenants Have Little Incentive for Conservation

Tracts of land rented without buildings and farms rented by women landlords had the fewest soil building and soil saving practices in the 1944 Agricultural Adjustment Administration program in one township in Polk County, Iowa, according to a study by I. W. Arthur and G. Jennett. Less than one-half of the women landlords had Agricultural Adjustment Administration soil conservation practices, while three-fourths of the men landlords had such practices. There were 30 rented tracts without buildings in the township but only nine had completed soil conservation practices. There were 60 owner-operated farms with 52 having one or more conservation practices. A rented tract without buildings is generally recognized as a short time arrangement. *Hence, there is little incentive for the tenant to go in for conservation measures.*

To make it easy for landlords and tenants to write leases including arrangements for soil conservation practices, I. W. Arthur of the Iowa Agricultural Experiment Station has prepared a lease rider which may be attached to a lease. This rider sets forth the different practices and has a blank space for the tenant and landlord to fill in the specific agreement on the division of costs and returns in each case.

Time looms large in conservation economics from the standpoint not only of the tenant but of the landlord and owner-operator as well. It is not enough from the individual's point of view that soil conservation practices return the principal, they must pay dividends in a big way or interest, that inescapable item of cost, will make them unattractive. In cold terms, $1,000 invested today must return $1,060 in a year's time or $1,123.60 in two years' time assuming a six percent rate. An investment of roughly $750 has to return $1,000 at the end of five years at six percent if it does not the farmer has no economic inducement to make the investment. In short, compound interest works fast, so soil conservation must pay good dividends to be attractive to the individual. On the other hand, if society through the government as its agency is making the investment a much lower interest rate and consequently a much longer time span can be used.

Conservation Investments Are a Risk

To those who question six percent as being too high, the answer is that it may be low when compared to other

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This paper was presented at the Annual Meeting of the *Soil Conservation Society of America,* Cincinnati, Ohio, December 9-11, 1948.

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Dr. John F. Timmons is Professor of Land Economics at Iowa State College. He is Chairman of the Soil Conservation Seminar and the author of bulletins and articles on land problems and policies.

opportunities the farmer has to invest his funds or in comparison to the risk he figures he is taking in making the conservation investments. The 2.9 percent interest on Series E government bonds involves little if any risk to the farmer and even more important the bonds can be exchanged for cash after a short initial period so that the funds are available for attractive investments that may develop. On the other hand, conservation investments are sunk. If a dry year occurs, the seeding may fail and the crop yields may be low; if a big "gully-washer" comes during spring planting season, it may wash out the terraces. And in any event there is no easy way to convert the seedings or terraces into cash except by waiting for the crops to mature.

Good landlord-tenant management is essential for profitable soil conservation. One of the foreclosed farms taken over by the Iowa State College Agricultural Foundation illustrates this point. When it was taken over this farm of 160 acres was badly eroded and run down. Much of the soil was thin Lindley, Weller and Clinton silt loams. The slopes varied from one to 20 percent with a large part of the tillable land ranging from five to 15 percent. A mortgage of $62 an acre put the farm under in 1929. The appraised value in 1938 was $25 an acre. In 1940 the value of all the farm land and buildings in the county was only $33 an acre. In short, this farm was distinctly low grade in a low value county.

In 1938, the year this farm was acquired, the 26 acres of corn on the farm yielded 31 bushels to the acre and the total value of all crops produced was only $551 of which the corn contributed $322. In 1948 the value of crops produced using 1938 prices was $1,933, almost four times larger than the earlier year. But the first five years of this intervening period tells an entirely different story.

When the farm was valued in 1938 the corn yield estimate for the farm was 26 bushels an acre. During the five years 1939-43 the actual corn yield turned out to be 29 bushels per acre. In this period a program of liming, phosphate, legume seedings and contouring was practiced. In 1943 the farm was reappraised at approximately the same value with a corn yield estimate of only 28.

Landlord net income averaged for the first five years only $70 a year. This $70 a year at five percent gives a value of only $1,400 for the farm. Furthermore, the income at the end of the fifth year was only $116 so that there was little indication of progress. On the assumption of an original investment of $4,000 to buy the farm at six percent interest, a deficit of $1,019 had developed over the five year period. The lime, phosphate, legume and contour program had not paid so far.

Landlord-Tenant Relations Important

A new tenant came to the farm in 1943 on a stock share lease. This tenant was a good manager and co-operator on conservation practices. Conservation investment increased. With the advice and assistance of Soil Conservation Service technicians, terraces were installed, gullies filled, and grassed waterways established. The results were as follows:

	1939-43	1944-48
Rotation acres	75	95
Legume and Rotation pasture	22	36
Corn acreage	19	33
Corn yield	29 bu.	49 bu.
Corn production	551 bu.	1617 bu.
Hay yield	1.2 tons	1.8 tons

The corn yield of 49 bushels for the 1944-48 period included a yield of only eight bushels per acre for 1947, the poorest year in the 10 year period, and also a yield of 70 bushels per acre for 1948, the best year in the period. Corn yields for the county as a whole were 45 bushels an acre for the 1939-43 period and only an estimated 42.4 for the last five years. Permanent pasture on the farm, it is interesting to note, declined from 72 acres in 1938 to only 30 acres in 1948.

Legumes, corn and good conservation management did the trick. The soil has been stabilized with a four-year rotation (corn-oats-two years legume) on the steeper slopes and with a six-year rotation (corn-oats-corn-oats-two years legumes) on the relatively level areas. The acreage of legumes and corn has been increased so that the farmer and his family now have an income comparable to that of farm families in the better soil areas. But it was not easy. Time, patience, careful study and assistance of the Soil Conservation Service technicians were required. And little might have been accomplished if it had not been for an energetic capable tenant and a landlord determined to cooperate with the tenant in building up the income producing power of the soil on this farm.

In this example, as in most, there are variables that change from farm to farm. Soil for one is a variable which responds to treatments in different ways. Rainfall and other weather conditions are another. Finally there is the management variable which is especially important on a rented farm where it is necessary to have two parties sold soil conservation before a successful program can be put into effect.

We are now ready to look at general principles. Conservation is not a unique problem from the standpoint of the individual farm as a business concern. The farm as any other business firm has scarce resources. From the limited land, labor and capital at his command the farm operator must fashion a producing plant which

yields maximum returns. Although maximization of dollar profit is not the only objective of the farm business, it ranks high in the order of priority.

The interplay of the two considerations—limited resources and profit maximization—largely determine how land or any other agent of production is used. We must fully recognize the goal of farm business and the environment within which its actions take place, otherwise progress towards levels of conservation which are economic to the nation will be retarded. An integrated conservation program needs to consider two avenues of attack:

1. *Isolation of those areas and their extent, in which conservation is profitable to the individual and can be facilitated through education and technical assistance.*
2. *Segregation of the forces which cause conservation (at the level economic to the nation) to be unprofitable to the individual and which can be handled best through public controls or payments.*

Conservation Profitable for Individual Farmer

Let us view the problem of conservation from the standpoint of the individual farmer. The problem here is not one of conservation or complete lack of conservation. Instead it is a question of the level or degree of conservation which is most profitable. The farmer is not concerned with whether he should or should not feed his dairy cows or plant his corn but with the rate of feeding or seeding which is most profitable. The problem of conservation is exactly parallel.

Two general types of decisions confront any business unit which has scarce resources. One of these relates to the best use of limited capital among several alternatives at a given point in time. The other relates to the best use of these resources among the several alternatives, not only of investment opportunities but also between investment or consumption or family living over time. The first is well represented in conservation by the decision of whether or not to contour as a means of retarding water run-off and hence increasing yields in regions of limited rainfall. Costs and returns associcated with the practice may be entirely realized within the year. The arithmetic is simple if the farmer has unlimited capital. The practice should be applied to the extent that the added returns are greater than the added costs. The mathematics become somewhat more complicated, however, under the typical situation where funds are limited. Here the farmer must determine whether an investment of (say) $100 will return more if invested in conservation practices or in protein feed for the hogs, building space for the poultry or nitrogen fertilizer for the crops. A somewhat parallel decision rests on whether or not to withdraw investment in the land now in order to obtain funds which can be reinvested in livestock, improved seed or machinery which will bring in an even greater return.

The second decision is often expressed in conservation as one of whether the individual should exploit his land in order to have funds for family consumption now at the expense of labor income and consumption. Again this problem is common to many segments of the farm as a business unit. Should the operator forego consumption now in order to invest in an improved dairy herd and a barn which will make possible a greater return five, ten or twenty years later? In general, what portion of his income should he spend currently and what portion should he reinvest for extension of the business and returns in later years?

Since soil and water conservation represents only one facet of the economic organization of the farm, we should not regard the problem as unique. Instead we need to determine the level of conservation which is profitable to the individual under the situations where (1) capital is a limiting factor and (2) where it is not a limiting factor. Then with true knowledge of this area all possible educational and technical assistance should be directed at extension of conservation.

Finally, adoption of a conservation program often means dropping to a lower level of income at the outset and before the yield effects of improved rotations and mechanical practices can be expressed in returns. This is illustrated in the data of the table below.

Income and Investment Expectancy on a 160 Acres Farm in the First Four Years After Adoption of an Erosion Control Farming System[1]

	First Year	Second Year	Third Year	Fourth Year	Fifth Year
1. Change in income as compared to existing farming system	$-387	$-242	$-122	$+469	$+804
2. Total Additional Capital required by years:					
a. For livestock	.....	$490	.....	$ 294	290
b. For conservation installations	.....	$206	$294	$ 119	.....
c. For fences, buildings and miscellaneous item	.....	$288	$337	$ 312	225

In all instances where soil conservation is profitable to the farmer, public responsibilities should be limited largely to research and education. Research is necessary to discover and develop the practices and systems which promote conservation. Education is needed to translate research into action on individual farms. The educational process can be speeded up considerably through incentive payments and technical assistance to farmers.

There are, of course, situations as discussed earlier where conservation pays from the farm viewpoint but for various reasons including rental arrangements and

[1]Based on data from project 976, Iowa Agricultural Experiment Station. Farm studied includes Marshall silt loam and associated soils.

lack of capital the individual farmer fails to follow the desired practices. In such instances, society has a responsibility to help remove such obstacles in the public interest of conservation.

Conservation Unprofitable for Individual Farmers

Public responsibilities for soil conservation, however, may and frequently do go beyond those practices profitable to individual farmers. This is particularly true where:

1. *Public interest is longer term and more lasting than the interests of individual farmers.*
2. *Benefits accruing away from the farm where improvements are made may justify greater expenditures on a particular farm than can be undertaken profitably by the farmer.*

These principles have long been recognized in land reclamation projects and flood control levees and dams. But only in recent years have they been incorporated into soil conservation programs. From the viewpoint of soil conservation, the Little Sioux Watershed Program in Northwestern Iowa serves as an example. This program, now in its early stages has a twofold objective: (1) to hold the soil and water in place, thus benefiting the land on which conservation improvements are made, but more important to hold soil and water from damaging all downstream areas with floods and silt (the goal is to reduce maximum waterflow by 20 percent and siltation by 55 percent), and (2) to help maintain the productivity of the land for the benefit of future as well as this generation of citizens.

Let us illustrate these principles in a specific subwatershed of the Little Sioux. The Nepper project, named after the principal land owner, Mr. S. A. Nepper, includes only 500 acres, yet, is costing $67,000 in on-site construction costs. This is $134 per acre of public expense in addition to what Mr. Nepper and his neighbors will spend on supplementary practices and maintenance measures. Obviously, individual landowners cannot afford to undertake such expenditures and make them pay out during their lifetimes. Yet, society may well afford this investment since its costs in terms of offsetting benefits can be distributed not only over future generations but also over hundreds of acres of land downstream which benefit from keeping water and silt in the Nepper area where it is an asset and not a damage.

This does not mean that society can use expected future and off-site benefits to justify any and all types of land improvements in the name of soil conservation. Care should be taken that public funds are expended where expected public benefits are greatest and beyond the costs involved. Care should also be taken that public investments on private land are adequately protected from exploitation by individual farm operators and owners. In this respect the soil conservation district is widely recognized as an appropriate instrument for protecting public interest. *To be effective, however, the district should be empowered to do more than merely facilitate education and technical assistance to farmers. It should through land use ordinances, if needed, establish and maintain minimum land use practices in the best public and community interest.*

To enforce such ordinances, if need be, the district should possess the power to tax in order that the district could carry out the ordinances if the individual defaults and charge the costs of the practices to the land. Our weed control laws and drainage district organizations afford widespread precedents for such action. The importance of soil conservation measures appears to be just as great or greater than weed control or drainage.

Finally, the district should have the power to require small but strategic acreages which are unusually severe sources of gullies and sheet erosion and retire such areas from farming. If such areas are widespread, it may be desirable to zone them out of farm use in favor of forestry or other more conservative types of land use. Of course, such powers must come through state enabling legislation. It is important that these types of control measures be preceded and supplemented by adequate educational programs in the interest of individuals going forward with conservation with a minimum of control measures.

The Muskingum Story

(*Continued from page* 16)

tion agencies in the improvement of lands. While the District can claim but little of the credit, our entire drainage area has become a huge soil conservation district, on a county unit basis.

Through such cooperation a start is being made in the reforestation of the two million or more acres of Ohio lands which seem unsuited to other agricultural use.

As a result of these improved soil, water and forest conditions, plus the new recreation facilities that have been made available, commerce and industry are showing a renewed interest in the Valley. People and organizations who have feared "too much government at the top" seem impressed with the District's program where the control is local. The various Federal and State cooperators appear delighted with the results and seem of the opinion that it enables them to do their most efficient and effective work.

Recently one of our leading citizens, in commenting on the District program, said: "I believe the founders of our government would be pleased with the Muskingum story." We of the Valley are hoping so.

The Denver Conservation Statement

- - - - *A Declaration of Principles*

The statement that follows was adopted at the Inter-American Conference on Conservation of Renewable Natural Resources held at Denver, Colorado, September 7-20, 1948. It recognizes that hunger and want are the results of exploitation and depletion of the natural resources throughout the world. The statement further outlines the duty and purpose that society must assume in the conservation of the renewable natural resources; also that legislation must be provided to guarantee conservation.

As representatives of the governments of the Americas we have met to take consuel with one another about the wise use of the earth's resources. Our deliberations have been guided by our awareness of the gravity of the situation in which the peoples of the world now stand. Everywhere in the world natural resources have been depleted by ignorant and reckless exploitation that has ignored the inexorable natural laws which maintain them, and this depletion was disastrously accelerated by the recent world war. Throughout the world steadily increasing populations have put an ever-increasing strain on the dwindling resources. These two forces, each of which re-inforces the other, have now brought mankind to an almost critical point. The challenge of our time is that we must arrest and reverse them or face the fact that the very existence of civilization will be brought in peril.

In some areas millions of people must live below a tolerable level of subsistence, and nowhere in the world has a proper living standard been achieved for everyone. Moreover, mankind is oppressed by fear of further wars. Much of this fear originates in hunger and want, in which lie the seeds of disorder from which might come the wars we so greatly fear. We believe that on the road toward peace the only guarantee of peace, is a careful development, utilization, and protection of renewable natural resources. We firmly believe that the earth is rich enough to insure a better living standard for everyone, provided that measures for such development, utilization, and protection are immediately adopted and adhered to by all from now on. We believe that, although our knowledge is incomplete, inexact and intermixed with error and misconception, nevertheless mankind now knows enough to devise effective measures and apply them with success. We believe that it is within our power to maintain civilization, to advance farther than we have now come toward the comfort and stability that are mankind's oldest dream, and to pass on to our successors an increased and strengthened natural heritage now being drained by our wastefulness. Finally, we recognize that in comparison to other parts of the world, the Americans have a greater natural endowment and have been less exhausted by war and exploitation. This good fortune lays on us a responsibility for leadership in meeting the challenge that we may by no means avoid or escape.

The crucial problem of our generation is to safeguard, maintain, develop, increase, and wisely use for the common benefit of mankind the natural resources of the earth.

During this Conference experts drawn from many disciplines of science and from many parts of the Western Hemisphere have analyzed this problem. In a spirit of the severest realism they have explored its complexity, pointed out the dangers we face, and discussed ways of meeting those dangers, correcting the errors that have been made, and avoiding errors hereafter. They have demonstrated that, precisely as hunger knows no frontier, so the crisis we face is common to us all, transcending national barriers and demanding a unified cooperation toward the final objective that must be as wide as the hemisphere. We feel necessity's nature and our meeting today should be considered a demonstration of that feeling. The earnest desire for peace, which all men cherish, must point the way to wider cooperation of peoples toward a purpose beyond this hemisphere.

The catastrophe that threatens civilization results from man's failure to live in harmony with the principles that govern his environment. Man has abused the earth that is his principal source of wealth; and the earth therefore dispassionately makes his existence even more precarious and threatens him with extinction. Until he brings himself to live in harmony with nature there is no hope for peace or plenty or progress. We declare that, in order to establish a harmonious relationship between civilization and the environment in which it must exist, it is both our duty and our purpose:

To put an end to practices that injure or destroy the renewable natural resources.

Figure 1. Delegates attending the Inter-American Conference on Conservation of Renewable Natural Resources held at Denver, Colorado, September 7-20, 1948.

To substitute for them practices that accord with nature's order.

To repair insofar as possible the damage already done to our renewable natural resources.

To safeguard and increase the land's productivity by every means that science can devise and planning by private and governmental enterprise can effect.

To maintain and protect to the utmost all the renewable natural resources.

To bring about a proper equilibrium between populations and the productivity of their lands through the conservation and development of renewable natural resources or other measures that careful study renders advisable.

To protect and conserve flora and fauna.

To protect and maintain natural zones of outstanding interest or scenic beauty.

To increase and disseminate among all people knowledge of the relationships betwen men and nature.

No generation can exclusively own the renewable resources by which it lives. Successive generations are but trustees charged with maintaining unimpaired the inheritance of their successors. We hold the common wealth in trust for posterity, and to lessen or destroy it is to commit treason against the future. The principal is the natural resources. The interest is the earth's ability to maintain their yield so long as natural relationships are preserved and so long as man will govern his activities and institutions to accord with them. No generation is free to spend more than the interest yielded by rational use of the heritage. On the contrary the duty of every generation is to apply its full knowledge to protect and increase the capital sum.

The problem implicit in our purpose is composed of many complex problems intricately bound together. It is so tremendous that it can be solved only by bringing to bear on it all the instruments of scientific and social knowledge and all the skills of politics. The many specialties of the physical and biological sciences must be focussed on it, together with the many techniques of engineering. But these are not enough. Conservation requires the coordinated assistance of all branches of Economics, sociology, psychology, anthropology—all these and many other disciplines must guide us in the application of what the basic sciences have shown to be desirable. It is no longer possible to approach this problem from a simplistic standpoint. The approach must be many-sided, utilizing our entire heritage of knowledge in a coordinated effort.

Inmpicit in our purpose is the constant augmentation of knowledge. Conservation requires continuous advance in our understanding of nature. It requires continually increasing effectiveness in the techniques of working with

(*Continued on page* 30)

Grasses—Man's Bread and Meat

B. W. Allred, Soil Conservation Service

OXYGEN
SUN
SUNSHINE
CARBON DIOXIDE
WATER
HOW GRASS OBTAINS ELEMENTS TO MANUFACTURE FOOD
Grass gets sunshine and carbon dioxide from the air, but minerals, nitrates and water are absorbed from the soil through the roots. Oxygen and water are given off through the leaf pores.
WATER
NITRATES
MINERALS
CALCIUM, PHOSPHORUS, IRON, POTASSIUM AND OTHERS
7-8-47 4-L-3663

Hendrik van Loon once said, "The history of man is the story of a hungry animal in search of food." History might then also be the story of man's constant search for grass, for it is the basic food source in the universe. Humans not only depend upon it, or upon the vegetable and animal products derived from it for food, but also for clothing and sometimes for fuel, shelter and power. Grass furnishes many raw materials for industry. It is used, too, in landscaping for the embellishment of man's habitat.

A thick spongy cover of grass provides a natural defense to soil against the destructive action of wind and water. Leafy grasslands keep springs in sustained, even flow.

Bottom.—Spread over the grazing lands are multitudes of plants in patterns of climax species that are adapted to various sites or locations. The climax plants are the supreme development of the climate and environment in which they grow. Plant community patterns vary largely because of differences in available moisture which is influenced by precipitation, soil, topography, temperature, light, elevation and latitude. For example, in the sub-humid U. S. prairies, the high-yielding bluestems, Indiangrass, switchgrass, and sideoats grama are climax; the more drought-evading or resisting western wheatgrass, needle-and-thread, buffalograss, and blue grama occupy the Great Plains; and evergreen trees grow in the high mountains of the west where coolness and higher rainfall provide for their special needs.

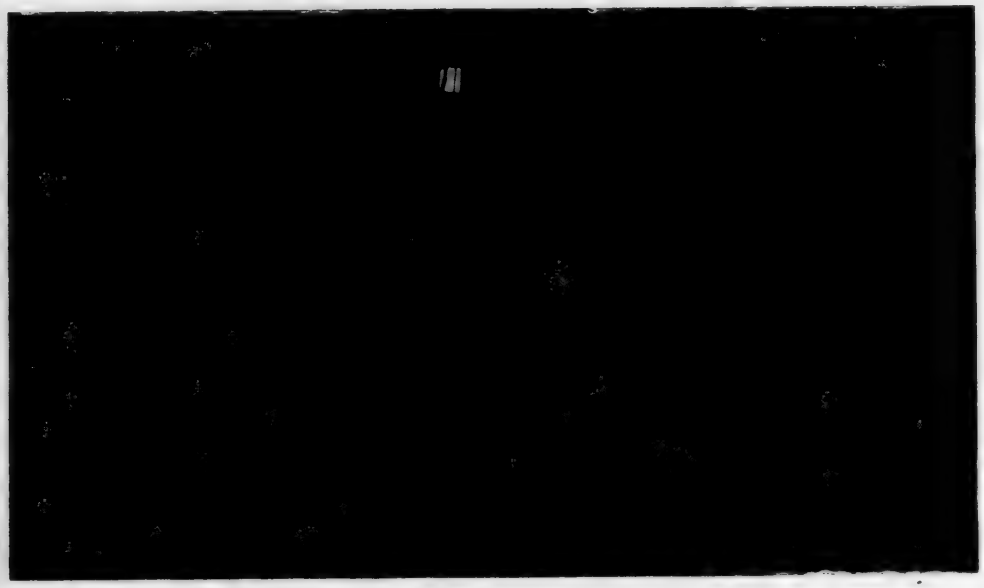
Before domestic livestock were introduced to the primeval continent the grasslands flourished. Not many ranges remain like the ones that fed the wandering buffalo and antelope. One of the bluestem ranges that has survived is seen in the photograph. Dewey Owens is shown riding his horse through the lush big bluestem range owned by T. J. Stockton on the Upper Verdigris Soil Conservation District, Nowata, Oklahoma. October 1948. This range has been correctly grazed and therefore has continued to produce its maximum.

Below.—Young W. D. Smith, Jr., Kentwood, Louisiana, watching the family cow prepare his meal. The cow is called sometimes the "Foster Mother" of the human race because she harvests and manufactures grass into food.

Left.—An antique, horsepowered hay baler s
serted in the vast range country, a stark remind
time, eight years ago, when this range was cov
thriving grasses that fattened cattle and prot
soil against wind and water erosion. Two bales o
kept in a good state of preservation by the
hood and the dry air of the locality. The bal
excellent grasses, most of them gone from t
now because of overgrazing. Only a few rem
main to support the baler's testimony that gra
flourished here. Plants making up the hay in th
baler were vine mesquite, blue grama, New
sagewort, and black grama, all very good fora
quality of the hay was still good in 1947, th
content being eight per cent, nitrogen 1.29
calcium .79 per cent and phosphorus .122 per
these percentages were adequate with calciu
especially high. Most of the present vege
sparse burrograss plants, low grade annual w
indigestible shrubs.

The soil now is largely bare, exposed to w
water. The invading plants that have taken
are shown in the photo, furnish little forage an
no protection against erosion.

Land operators who know the most abo
grasses and understand how they grow have
grasslands. Those who know how to recog
interpret the natural patterns of land and pl
munities can tell how good a range is by look
Therefore, ranges are graded according to
classes so that land operators can tell how good
is and how much better it may become unde
grazing. The next four pictures show the fo
condition classes on a limestone hill site in th
Pecos Soil Conservation District, which has
ters at Pecos, Texas.



Above.—This range is in *excellent* condition. Plant cover is made up of 75 to 100 per cent climax or original plants. Forage production and soil protection are maintained at highest levels. No more than 50 per cent of the annual growth should be grazed.

Below.—The range here is in *good* condition, with 50 to 75 per cent of vegetation composed of climax plants. Production is two-thirds or less of maximum and soil protection is adequate as long as 50 per cent of the yearly plant growth is left.

This range is in *fair* condition, with
25 to 50 per cent of vegetation composed
of climax plants. Forage production is generally
less than half of maximum. No more than
half of the climax plants should be grazed.
Total forage production is often inadequate to
protect the soil on this site when the range is
in fair range condition.

Top Right.—Poor condition ranges that have sufficient climax vegetation left to reseed them can become excellent if given lenient use and alternate rests for a period of years. This is the simplest and most profitable way to improve ranges. However, ranges, like the one shown in the illustration, which have lost a proper seed source because of intense grazing, burning or plowing, must be replanted. Hardy adapted foreign grasses have been requisitioned for use on many abandoned farm lands. But most of the grass seed used in revegetation in the southwest has been harvested from native rangelands.

Right.—Three self-propelled combines under contract to the Soil Conservation Service harvest wide swaths of native bluestem and Indianagrass seed on the T. J. Stockton ranch, 10 miles west of Nowata, Oklahoma. Rainfall was abundant in northeastern Oklahoma in 1948 and a bumper grass seed crop resulted. Over three million pounds—a world record crop—of big and little bluestem, Indiangrass and switchgrass seed were combined, cured, cleaned and sacked by the Soil Conservation Service, by district supervisors and by private operators.

Below.—Part of seed from the mammoth bluestem harvest is pictured being stirred to avoid heating and to speed drying. This seed was harvested by the Caney Valley Soil Conservation District, Bartlesville, Oklahoma. Seed from this harvest is going to Oklahoma and north central Texas soil conservation districts. In spite of the bountiful harvest the supply of seed falls far short of district requirements.

This range is in *poor* condition. None to 25 per cent of the plants are climax or original kinds. Production is generally 25 per cent, or less, of maximum. No more than 50 per cent of the climax plants should be grazed. Total forage production on this site is generally inadequate for soil protection when ranges are in poor condition. When there are no longer enough plants left to reseed the range, seed of such plants must be artificially introduced to hasten recovery.

Above.—Yowell's weeping lovegrass stand is shown here in September 1946. Weeping lovegrass is an African grass which has been naturalized successfully in the American midlands south of latitude 36. This productive grass provides excellent fall and early spring grazing. In summer the grass becomes too tough for top grazing. It seeds prolifically and the hay is excellent for horses and range cattle.

Below.—Ranchmen have always banded together for their common good. In the old days they worked and rode together to route cattle and horse rustlers or hunt down wolves and cougars.

The photograph shows a group of Menard County Soil Conservation District ranchmen and range men making a check of the range condition classes, soil erosion, poisonous plants and brush control.

Notes on Land Use in Holland

G. W. MUSGRAVE

The essential key to the success of agriculture in Holland seems to lie in the fine balance which has been achieved between good management of soil, of animals, of water, of nutrients, and of plants. This, Mr. Musgrave emphasizes, is the result of a successful land use and soil conservation program that has been practiced as early as the year 800.

TO ANY TECHNICIAN working in the field of soil conservation many of the essential and highly important items in the program of land use in Holland are the same items that a technician would like to see in equally successful operation in this country. Pastures such as I have never seen before—with management practices that a conservationist would dream about—are common. *Crops that are grown only on soils for which they are particularly adapted are a common feature of their agriculture.*

A visitor to Holland is impressed by a type of wind-erosion control in the bulb-producing areas—one that is both unique and of the utmost effectiveness; likewise by the wind-erosion control of sand dunes along the coast, where meticulous attention is given to well conceived measures for the control of sand dunes that sometimes exceed 200 feet in height. Only during the period of German occupation did this attention temporarily lapse. An agriculturist is also impressed by the detailed mapping of the essential features of the soil, many of which are now shown on maps of a scale of 1:10,000 (1 inch = 833 feet). There are now fifteen local centers from which studies pertinent to the surveys are conducted.

In an area of 13,200 square miles (approximately ¼ the area of North Carolina) there are research and operations programs at Groningen, Kampen, Goes, Walcheren Island, at the University at Wageningen, and elsewhere, conducted by many different agencies and branches of the Government. These agencies are so numerous that this observer did not get a clear picture of the organization during the period available, but it appeared that all of them were actively, cooperatively, and effectively advancing the cause of proper land use throughout the Netherlands. In fact, one gains the impression that the relative expenditures and intensity of

G. W. Musgrave is a Research Specialist with the Soil Conservation Service. He was an official delegate of the National Research Council and the Department of Agriculture to the Oslo Meeting of the International Association of Hydrology and the International Union of Geodesy and Geophysics. En route to Oslo, Mr. Musgrave stopped to examine several soil permeability problems, of which those in Holland have a particular significance to the United States.

The photographs are from "Boor en Spade 1, 1948" (Auger and Spade1), Soil Survey Institute, Wageningen, Director Professor Dr. C. H. Sdelman. In addition, Mr. Musgrave also acknowledges the courteous assistance given by Dr. Schuffelen, Dr. C. Van den Berg, and their co-workers.

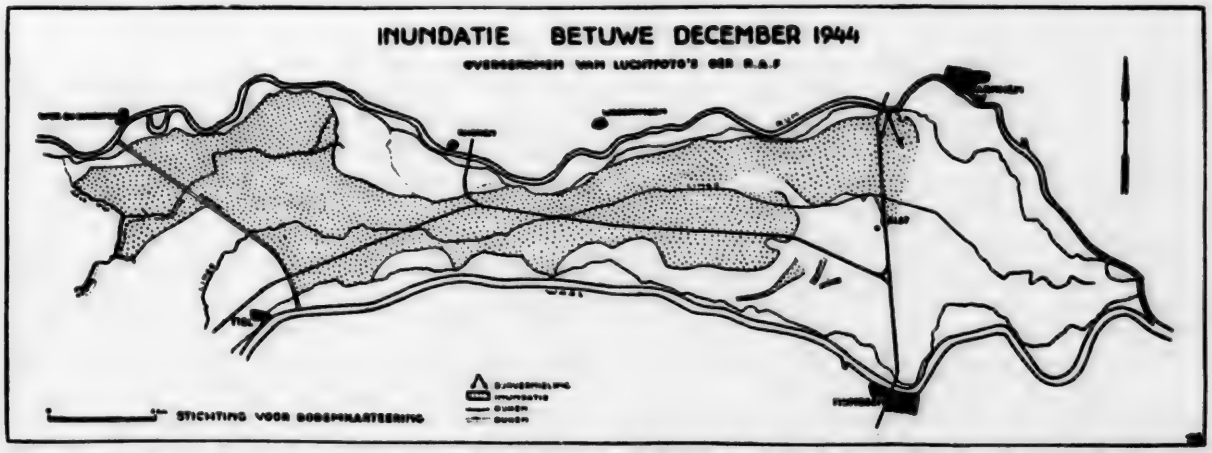


Figure 1. This map shows the inundation of the Betuwe and the spot where the dike was blown up, west of Arnhem (see arrows). The area lies close to the German border and it is easy to see how the flooding between the fingers of the Rhine in its lowest floodplain was an effective way of impeding military movements. Damage to land, however, is entirely different from that done by salt water, as occurred on Walcheren Island.

work in this small area far exceed that in the United States.

Land Damaged by Salt Water

One of the most pressing problems in Holland, of course, is the rejuvenation of the lands that were inundated by salt water during the recent war. The damage done by the salt water was not entirely chemical. Severe physical damage also resulted because the current of water washing back and forth through the gaps in the dikes cut cavernous channels through fields of choice land. These, in some instances, are believed to be too large to be repaired. Soil, to a depth of 20 to 30 meters and of similar width, has been removed to a distance of several miles from the coast. This loss of land represents the actual loss of numerous farms, because most of them are of small size.

The inundation in some places lasted continuously for several months, while in other places the land was under salt water only intermittently. Of the two conditions, it is believed that the land under intermittent inundation suffered more severely from the sodium and chlorine of the salt water than did the land that was continuously under water.

Two different effects were produced by the salt of the sea water. The sodium absorbed and attached to the surfaces of the clay particles adversely affects the structure of the soil and its permeability. The chlorine ions are toxic to many crops, the relative sensitivity of which has been determined by field tests. For example, the yield of peas falls off rapidly as the chlorine content of the soil increases, while summer barley is relatively resistant to such effects.

The effect of sodium on structure is most marked on soils exceeding 20 percent clay. On soils having six percent or more of humus the structure tends to be preserved, but humus and clay contents are correlated so that the benefits of humus are partially offset by the greater chlorine content of the heavier soils.

That poor soil structure results in part from raindrop impact is recognized by the Dutch technicians. Even though rainfall is light by comparison with many parts of the United States, the merits of a protective vegetal cover are recognized. Alfalfa is regarded with especial favor for this reason. However, it is also recognized as being inferior to grass insofar as building soil structure is concerned.

Land Treatment Is Effective

Field and laboratory studies for the repair of the chemical damage of the soil structure early disclosed an effective treatment. The application of gypsum (crude calcium sulphate) has the effect of replacing sodium and chlorine ions. The rate of replacement is more rapid in wet seasons than dry, and is more rapid on some soils than on others, but in general the treatment has been effective everywhere, though varying in degree.

These soils get only one application of gypsum because of the cost involved, since all of the material must be imported. Thus the rejuvenation of the soil occurs first at the surface, and one of the essential features in the recommended practices is that the soil must be plowed shallow at all times so that deeper, more saline material is not brought to the surface.

Another important item in the practice is that crops least sensitive to salt be grown on the more saline areas, while the more sensitive crops are grown on the areas where the salt content is low. This calls for detailed field tests of the soil, the mapping of areas of different salinity, and recommendations to farmers in accord with the findings.

In going over Walcheren Island, most of which was inundated, one sees highly satisfactory crops everywhere. Although the island is completely devoid of trees except in a few small areas where interior dikes prevented the inundation of salt water, good crops are common and the recovery is amazing. Plans for landscaping the island have been formulated, but fulfillment of the plans awaits completion of more pressing projects.

One is impressed not only by the success of the whole thing and the practicability of treatment, but also by the extent to which farmers adhere to the recommendations that are made by the technicians. There is so much confidence in the technical advice given the farmers that apparently there is no hestitation whatsoever in applying it to each farm and parcel of land.

This confidence on the part of farmers in the technical advice they receive is attributable in no small part to the excellence of the factual information on which it is based. Extensive basic research, correlated field plots, and coordinated and carefully checked field scale tests provide a fund of most useful information on proper land use. Experience has proven the accuracy of the information and its value to the practical farmer.

Wind Erosion Program Far Reaching

Mere casual observation of the wind erosion-control practices arouses the greatest interest of the technician. In intensive horticultural areas, sandy soils are usually selected or even "made" by inverting peat-sand horizons. Small areas, about 2 x 6 meters in size, are surrounded by a double row of small grain that is allowed to stand until after the harvest of bulbs or other products. Thus miniature windbreaks are provided and are effective particularly before the interior area is planted or after its main crop (perhaps bulbs) has been harvested. Groups of these small areas are surrounded by neatly

Figure 2. Landscape on old sea clay near Zoetermeer, east of The Hague, an area where the peat cover is removed and the old clay is now on the surface. The difference in the soil is to be seen in the inequality of the crops.—(Foto Geall. Luchtmacht. Archief S. v. B.)

trimmed hedges that effectively reduce wind velocities over these groups of "plots." Not uncommonly, a straw mulch is applied to the land surface. Organic matter in the form of manure or compost is normally returned to the maximum extent possible. Thus, despite a vulnerable soil and prevailing coastal winds of considerable strength, the soil is safely protected.

In the coastal sand dune areas winds of considerable strength and frequency also occur. Dunes exceeding 200 feet in height are not uncommon. But due to regular and detailed attention to areas requiring grass, shrubs, or trees, these dunes are well anchored. Expressions of regret were heard that during the German occupation the usual attention to this problem could not be given. Some of the work is done by the Province concerned, while much of the planning and research information comes from the National Government or the University.

In the interest of improved land use and still more efficient farming, the Government also has underway a program of land acquisition and reassignment. During past years, through inheritance or otherwise, farms became divided into many small parcels. Not uncommonly, the holdings of a single farmer were divided into ten or more separate areas. In one instance a farmer owned and operated a tract of a few acres 20 kilometers distant from his home. A recent law provides that where 50 percent or more of the owners agree, the numerous parcels may be bought by the Government, new roads and canals laid out, and the holdings reconsolidated and reorganized for efficient operation. Reorganized units are then sold to former owners of scattered holdings. A given farmer may get land of either somewhat better or of inferior quality to that he had before, but he pays accordingly. More important, however, is the fact that consolidation of fields into an efficient operating unit has been achieved. Much of Walcheren Island, where inundation necessitated other reclamation measures, is being reorganized somewhat along these lines.

The interest of the Government in directing the growth of cities toward the less valuable agricultural lands attracts the attention of the visitor who has regretfully observed something quite different in the United States. He immediately thinks of the high quality lands that have been swallowed up by cities—to the detriment of his own country. The less valuable agricultural land oftentimes is considerably more scenic and certainly more effectively used for suburban development than are the level, choice agricultural lands.

When plans for expansion of suburban portions of The Hague were recently formulated that included proposed extensions into some of the most valuable bulb-producing areas in Holland, the technical authorities rose in opposition. The evidence was insurmountable that such would be of the utmost folly, since the produce of these choice lands was instrumental in greatly aiding the established goal of balancing the nationl economy. It was then found quite possible to direct the proposed expansion in another direction. Inferior quality land could be used for housing projects, but choice land must be saved for its most effective use.

Water Balanced with Crop Needs

One factor that has contributed greatly to the success of their land use is that of water control. By keeping a proper balance between available water, nutrients, and the kind of crop, very effective results are obtained and production reaches surprisingly high levels. A glance at a map of Holland shows that much of its agricultural land lies upon what is actually a delta of the Rhine, the Mass, and Scheldt rivers. Practically all of this land has been drained and the water levels are under control. For this purpose both open canals and tile drains are utilized. Where the land is below sea level, the surplus water is pumped from the canals. The legendary windmills which formerly did this job have now been replaced by modern diesel engine-driven pumps.

The canals which dot the land at frequent intervals are used for transportation as well as for drainage. The long, narrow canal boats are used to transport produce to tidewater ports and to bring return cargoes of various supplies, such as coal or brick, machinery, etc., to the interior.

Reference has already been made to the extraordinarily fine pastures which are seen everywhere upon these lands that have a proper balance between water, nu-

trients, plants, and good management. On these pastures one can observe such practices as hand clipping of weeds, the application and spreading of manure, and the application of lime and phosphate; and of course carefully planned and regulated grazing.

It is not uncommon to see as many as fifty large animals grazing upon as little as 10 acres of land—with vegetation so lush that it extends above the level of the animals' hoofs. These pastures often carry as many as two head of cattle per acre for the entire year. During the spring, summer, and fall period, the cattle remain entirely upon the grassland, and milking is done in the pastures rather than in the barns.

The essential key to the success of the whole program seems to lie in the fine balance which has been achieved between good management of animals, of water, of nutrients, and of plants. When one delves briefly into the local history and learns that much of the land was under cultivation as early as the year 800, and that in all probability agriculture antedated even that year, one cannot help being impressed by the successful soil conservation and intensive land use that has been practiced over so long a period of time.

Denver Conservation Statement

(*Continued from page 22*)

nature. Research must underwrite our hope. It must be enormously extended and provision must be made for it at every facet of our problem. Moreover, time is short and researchers are scattered, not always in communication with one another, not always able to call on one another for help or information. They must be given ways of coordinating their researches, of helping one another with common problems, of avoiding the waste of duplicated or mistaken effort. Clearing centers of conservation knowledge must be provided or expanded, and the exchange of information among those who study these problems in the various countries must be intensified.

Implicit also is a much more comprehensive program than any now existent for the training of technicians, especially of those who work most directly with the land itself and with the people who get their living from it.

Ultimately, however, conservation rests on the individual's knowledge of the ends it envisages. We depend upon one another and the man who lives and works in a metropolis without ever seeing the fields that produce his food should be as concerned about those ends as the man who cultivates the fields. In his turn, the farmer is under obligation not to impair the land that produces the city's food. Everyone must be able to recognize harmful practices in the treatment of resources and must adopt the procedures that will prevent them. The end in view is that people everywhere will understand that their dependence on the earth lays on them the obligation of respecting the earth and of protecting it in order that they may enjoy its fullness. Toward this end it is the duty of governments and their agencies, of religious institutions, of public and private foundations, of universities and colleges and schools, the press, radio and motion pictures to provide instruction that will make clear the penalties of violating the physical laws of nature and the rewards of living in accord with them. To grow in knowledge of nature and human life is to grow in conservation wisdom. There is no school too poor or too elementary, there is no agency of society too exalted or remote, to assist in the widening of knowledge. The function of education is twofold: to bring about an immediate understanding of the crises we are in and of the ways of resolving it, and with the passage of time to illustrate the goals toward which we work so that men's thinking and their institutions will come naturally to conform to them. We have learned at sore cost that where there is the greatest ignorance there is the greatest danger.

Governments must implement conservation; they must provide legislation that will guarantee the conservation of natural resources; they must create agencies that will preserve them for the fullfillment of their important social function; they must arbitrate among conflicting interests and, when necessary, supply such controls as specific problems may require; they must support education and scientific research. Every government must amplify and extend its cooperation to other governments in the work of conservation, in planning and direction, in bringing about the vast common attack on problems that no more respect the boundaries of a political unit than a flood respects them.

Henceforth conservation, the maintenance in full vigor of the renewable natural resources, cannot be a merely professed faith, acted on only sporadically and in part, ignored and violated in the interest of immediate gain. It must be acknowledged as the principle that must govern the actions of individuals and societies alike if progress is to remain possible. Time and events have shown us that the earth determines the pattern of man's fate, posing a choice which for a few moments we are still free to make. Our faith is that we will make the choice which can save us. We hope that this Denver Conference has served to set the vital choice in a clear light.

Flood Control and Conservation

LIEUTENANT GENERAL RAYMOND A. WHEELER

A proper understanding of the relationship of flood control and conservation is of utmost importance. This paper clearly defines the general scope of some of the activities of the Army Engineers on the lower reaches of river basins; also the work of the Soil Conservation Service, Forest Service, and other groups on the upper portions of river basins.

IT IS A PRIVILEGE to meet this morning with the members of the Soil Conservation Society of America—to discuss mutual interests with you who are doing so much toward the comprehensive improvement, development, and utilization of our national resources in the interest of all the people.

The pioneers who came over the Alleghenies and down into the magnificent valleys of the Ohio, the Mississippi, Missouri, and the great plains of the West were concerned with two primary things—fertile land and adequate water. Given these, they could create their own fields of opportunity—and they did.

Today, we—you and I—are concerned with these same two fundamentals of life and well being. We are concerned with land and water, their preservative improvement and greater utilization for the benefit of all of us—today and in years to come.

Agriculture has always been our basic industry, the foundation of our national prosperity and welfare. But, today, it is more than this. It is the hope—perhaps the salvation—of a troubled world. We may not now assay the influence which our agricultural production, and its distribution among the underprivileged peoples abroad, will have in shaping the future course of world events. But we know, beyond doubt, that the influence will be profound—as any great humanitarian effort must be—in creating the kind of world for which we stand—for which we have fought. Consequently, we who are charged with the protection of that production have a great responsibility. We are, as it were, custodians of the world's reservoir in the time of famine.

Resource Development Important

Within the recent post-war years, during my tour of duty as Chief of Engineers, I have had the opportunity of renewing first-hand my knowledge of America, its great progress, its immeasurable potentialities, its growing needs, I have seen farms, mines, industries, and rich, extensive oil lands that have been developed magnificently to produce the bounty they afford. I also have seen, and have been impressed deeply by, the urgency to conserve and restore our nation's original abundance of fertile land—and the increasing importance of bringing the waters of our rivers under control—preventing their flooding our lands and putting them to work to meet the growing needs of an expanding population and a progressive people.

Any program designed to develop our nation fully must recognize that the management, improvement and development of the natural, renewable resources of the country—soil and water—and the interests of industry, commerce, agriculture—the social and economic welfare of the people—are inseparable.

Students of the problem, such as the members of this group so ably have proved themselves to be, and others who have devoted their professional years to this work, have long recognized this fact. No human being who wears clothes, eats food, or lives in houses can continue to exist unless the land continues productive. And yet the soil of this nation has been tragically impoverished throughout the years by the encroachment of civilization and by wasteful land management. Man has invaded the forests and the fields, and until comparatively recently, he has taken little account of his ruthless wastefulness.

Yet when the soil wastes away, it causes untold economic damage and human suffering. It also increases greatly the burden of those persons and groups who would conserve the soil, and those who undertake to deal with the essential problem of flood control.

Soil erosion is a plague to the farmers and to the engineers. It robs Peter, but it does not pay Paul. It denudes the land, it pollutes our streams, it destroys the habitat of fish, it silts the channels for our water-borne commerce, and it increases the cost of providing control and utilization of our rivers.

These conditions, and these problems, are daily becoming more self-evident to ever-increasing circles of citizens. Spearheaded by alert, progressive societies such as your own, numerous groups and agencies—both national and state—are becoming more and more acutely concerned

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Lieutenant General Raymond A. Wheeler presented this paper at the Annual Meeting of the *Soil Conservation Society of America* held at Cincinnati, Ohio, December 9-11, 1948. He retired as Chief of Engineers, Department of the Army, on February 28, 1949, and is now Consulting Engineer for the International Bank of Reconstruction and Development, Washington, D. C.

with the application of large-scale programs of soil conservation and flood control. This concern has resulted in differences of opinion and in debate — sometimes, acrimonious debate. But in the last analysis, this is wholesome, and eventually it will be helpful. It is the constructive, American way of progress.

As related to flood control, these healthy discussions are almost exclusively related to *methods*. The *need* is universally recognized. Damage to farmlands, to highways, to industrial districts, to wild life, and to human life, has been felt so keenly that few people today fail to appreciate the imperative necessity of dealing with floods properly and effectively.

Floods Are Not New

The necessity for flood control has increased in direct ratio to the development of the country—the increase in population—the development of farms, the growth of industry, and urban centers. Floods, themselves, are not new. They are as old as our recorded history. For example, the Mississippi River was in flood stage in 1543, two years after De Soto discovered it. On the Upper Mississippi, more than a hundred years later, the intrepid Marquette and Jolliet found the river over-flowing its bank and filled with the debris of a flood-ravished country-side.

Erosion, however, as we understand it today—with its pressing watershed problems of run-offs and related effects of improperly cultivated fields and denuded forest lands—is relatively new to our young, quickly developed country. Erosion control today is of primary importance and must be recognized as an integral part of comprehensive, nation-wide flood control planning.

Congress recognized the complexity of the over-all flood control problem, when on June 22, 1936, it established a definite flood control policy for the Federal Government. The Flood Control Act of that date made flood control a statutory function of the Corps of Engineers. It directed also that investigations of watersheds and measures for run-off, waterfowl retardation, and soil erosion prevention be under the jurisdiction of, and prosecuted by, the Department of Agriculture. No conflict of interests occurs in this assignment of responsibilities, since the work and investigations are each highly specialized and different.

Writing recently in the "Constructor," our mutual friend, H. H. Bennett, Chief of the Soil Conservation Service of the Department of Agriculture, stated: "The two departments are working closely together through the Army Engineers of the War Department, and the Soil Conservation Service and Forest Service of the Agriculture Department, respectively, along with the help and cooperation of other Federal, State and local agencies and organizations."

The Corps of Engineers has no set, inflexible plan of flood control. The wide diversity of the rivers of the United States necessitates separate plans for each geographic region, and even in seperate parts of a single, large river basin. Each watershed requires special study and a special plan. Consequently, in carrying out its part of the over-all Federal program of conservation and use of water resources, the Corps of Engineers, in accordance with Congressional authorization, has been engaged in continuous review of its river-basin studies. We keep them up-to-date and in step with changing conditions. We also maintain a close coordination with the other Federal agencies, with respect to the river-basin problems under their jurisdiction, and with the States and local agencies of the respective basins.

Basin-wide Flood Control Programs Essential

In cooperation with the Soil Conservation Service, the Corps of Engineers prepared a plan of improvement for the Little Sioux River Basin, in Iowa. Under this plan, authorized by the Flood Control Act of August 1947, the Engineers proposed a system of levees and a program of channel straightening and enlargement and allied works on the lower reaches of the Little Sioux River and its tributaries. The Soil Conservation Service proposed a program for soil erosion prevention and run-off and waterflow retardation in the upper portion of the basin. The combined program constitutes a practicable basin-wide flood control program in which the works of the two agencies are complementary.

Currently, the Engineers are studying a system of major flood control dams on the main stem of the Gila River in Arizona and New Mexico. In this study, we are working in cooperation with the Soil Conservation Service to obtain a properly coordinated program of development for the water resources of the Gila River Basin.

The Corps of Engineers and the Soil Conservation Service have prepared concurrent reports on flood control in the Osage River Basin in Missouri and Kansas. In these reports, the Soil Conservation Service studied the effects of a program for run-off and waterflow retardation and soil erosion prevention in aid of flood control. The plans presented in both reports have been completely coordinated, so that there is no duplication in benefits to be derived from the programs or costs.

The Soil Conservation Service of the Department of Agriculture, in cooperation with the State of Florida and the U. S. Geological Survey, made an exhaustive study of "Soil and Water Control in the Everglades Region." The report on this study was completed in

1947. In addition to providing valuable basic data on soils, geology, climate and water requirements, the report also presented plans and recommendations for water control for the Everglades region. This comprehensive plan was of great assistance to the Corps of Engineers in preparation of its report covering major drainage and allied flood problems of control in Southern Florida. This plan of water control was authorized by Congress in the Flood Control Act of 1948. When completed, the project will prevent a repetition of the heavy flood damage experienced by southern Florida in 1947 and 1948. It also will preserve vast natural areas for conservation—providing an unexcelled habitat for fish and game, and water for replenishment and maintenance of ground water supplies. Of even greater importance, however, from a long-range standpoint, the water control plan for southern and central Florida—which, as I have said, is based on cooperative studies of the Soil Conservation Service and of the Corps of Engineers—will, with the improved land use practices being promulgated by the Department of Agriculture, preserve as a permanent and valuable national asset the vast muck-lands of the Everglades.

Joint Responsibilities in Drainage

Another broad field of land conservation included in the activities of the Corps of Engineers and the Department of Agriculture is that of drainage. The Flood Control Act of 1944 specified that flood control should "be construed to include channel and major drainage improvements," and, as you know, the Soil Conservation Service is authorized to provide assistance to all soil conservation districts, and to other state and local agencies, on drainage and related problems. Thus, the Congressional authorities available to the agencies enable them to cover adequately the entire field of drainage improvements—from management and use of surplus water on farms, to the major works necessary to control, use, or carry off the surplus waters of a wide area.

I am happy to advise you that on June first of this year a memorandum of understanding was signed by Mr. Bennett, Chief of the Soil Conservation Service, and myself, setting forth the basic procedures which the two agencies have found to be in the public interest, in carrying out their responsibilities for drainage activities. This understanding has been furnished to field personnel of our respective agencies and forms the basis of our approach to this problem.

I will mention only the basic considerations involved in major drainage improvements by the Corps of Engineers. These considerations are now written into instructions to all of our Divisions and Districts. First, we recognize that there exists more than 40 million acres of agricultural land seldom—or never—used because they are too wet for full agricultural production. Yet, these lands can be brought into production through a combination of flood control and drainage. They afford our richest potential for future use. However, we recognize most clearly that it is not desirable to drain all swamp, marsh and overflowed lands. Much of such land is not suitable for long-term agricultural use. And much of it is of such poor quality that its greatest usefulness lies in the production of forests, or as a habitat for fish and wildlife. Consequently, in all cases where drainage improvements are contemplated, careful consideration is given to the requirements for preservation of fish and wildlife, and for preservation of natural areas of unusual scenic or conservational interest. The Soil Conservation Service concurs in this approach, I know; and I believe that the two agencies now are ready to proceed on a firm basis for further development of this great resource.

In this manner is the progressive development of planning for the control and use of water resources by the Corps of Engineers accomplished—through the close cooperation of established Federal agencies: The Department of Agriculture in the several fields in which it is expert; the Bureau of Reclamation and other services of the Department of Interior; and the Federal Power Commission. It is accomplished with the cooperation of State officials and agencies. But in all our basin-wide development programs, we, who are responsible to the people through the Congress, have been impressed again and again with the need for the fullest participation of all responsible citizens. Our land and its resources, our waterways and their great potential benefits, belong to the people. Their preservation and development must come from the people.

Real Danger — Starvation

The *New York Times*, December 21, 1948, reports Sir Hartley Shawcross, Britain's Attorney General, as stating that "the tragic desperate truth is that the countries of the world are so preoccupied with their national differences and jealousies and conflicts, so concerned with the prospect and the dread of war, so burdened with military expenditures that they pay scant attention to the real and calamitous danger which before long may easily confront the world—starvation." At the same time, Tom Williams, Minister of Agriculture and Fisheries, stressed the precarious state of England's food supply. The failure of a single harvest in North America, said Mr. Williams could be "disastrous to Britain."

Dividends From Conservation Farming

E. L. SAUER

Money spent on conservation is a sound investment. Net farm income according to the studies reported in this paper is increased in one to four years. It also provides a safe basis for establishing credit to put conservation programs in effect.

BEFORE ADOPTING any new conservation practice or program, the farmer wants to know *"What will it cost?"* and *"What are the benefits?"*

The farmer is the one who can make conservation work on his land. Most farmers are in business to make a living. That is why it is important for them to know what conservation is and how it affects their farms and their incomes.

In 1936-37 research studies in the economics of soil conservation were set up with the idea of getting practical information that would help farmers and those working with farmers. The studies were conducted cooperatively by the Department of Agricultural Economics and Agricultural Experiment Station of the University of Illinois and the Research Division of the Soil Conservation Service, United States Department of Agriculture. To get practical results, the farm was used as the laboratory. Farms following conservation plans and practices were compared with neighboring, otherwise comparable farms not following conservation plans and practices.

Contouring Results in Crop Yield Increases

Contouring, contour strip cropping, grass waterways, and terracing are among the most popular and widely used mechanical conservation practices. To measure the effects of these practices, yields of crops grown on the contour, in contour strips, or on terraced fields on the contour were compared with those of the same crops grown on the same farms up and down hill or in the usual field pattern. Insofar as possible this comparison eliminated differences in management and in practices other than contouring. Yield results for a seven-year period are summarized in Table 1.

Table 1.—Yield Increases for Crops Grown on the Contour Compared With Farming Up and Down the Slope on the Same Illinois Farms, Seven-Year Average, 1939-45

Crop	No. of farms	Increase from contouring	
		Bushels per acre	Percent
Corn	124	6.9	12
Soybeans	48	2.7	13
Oats	46	6.9	16
Wheat	40	3.4	17

Costs of Contour Farming

The effect of contour farming on total farm operating costs was studied on 270 Illinois accounting farms for four years 1940-43. Farms on which all or most of the farming operations were on the contour were matched with comparable farms which followed a similar pattern of farming but on which few if any field operations were on the contour. This study indicates no significant difference in total expense for labor, power, and machinery between farms operating on the contour and those not on the contour (Table 2). The small difference in expenses favored contour farming.

Table 2.—Man Labor Costs and Power and Machinery Costs Per Crop Acre on 135 Contour-Tilled Farms Compared with 135 Farms Not Contour-Tilled, Four-Year Average, 1940-43

Item	Contour-tilled	Not contour-tilled
Man labor costs	$11.20	$12.04
Power and machinery costs	7.46	7.82

Effects of a Complete Conservation Farm Plan on the Farm Business

Studies were also made in selected areas of Illinois to determine the effect of soil and water conservation programs on crop and livestock production and on farm incomes. These studies compared matched high— and low-conservation farms. The farms had similar land-use capabilities and were similar in size but used different amounts of soil and water conservation practices. In other words, they were alike in physical characteristics but different in the degree to which they applied conservation practices.

Both the high- and the low-conservation farms were selected from the farms of Illinois account keepers and

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survey record cooperators and may represent better-than-average management for their respective areas. Both groups may also have done a better job of conservation than the average farm in the area. The high-conservation farms, however, have invested more capital for land improvements, conservation practices, buildings, etc., in operating the farm business than have the low-conservation farms. They have also more nearly met their needs for minerals, such as limestone, phosphate, and potash, and have put into effect more water-disposal practices, including contouring, terracing, grass waterways, etc., and more pasture-improvement practices.

That the benefits from a conservation program increase from year to year is shown by 10 years of records in McLean County. The per acre net income on the 20 farms with present high conservation scores was lower in 1936 than on the 20 physically comparable farms with present low scores. But in 1936-40 it was $2.36 higher, and in 1941-45, $4.17 higher (Figure 1). For the 10-year average, it was $3.46 higher, or $5,536 more net income for a 160-acre farm for the 10-year period 1936-45.

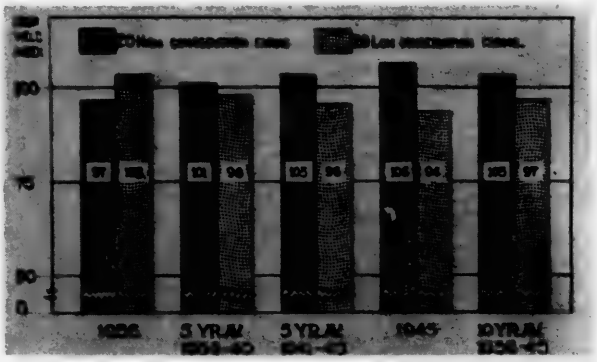

Figure 1. The per acre net income on the high conservation farms for the 10-year average was $3.46 higher than on the low conservation farms.

Increased yields accounted for an important part of the difference in earnings between the high and low farms (Figure 2). On the high-conservation farms corn yields were three bushels an acre higher in 1936-40 and six bushels higher in 1941-45. This increase in yield on the high farms is due largely to better land use, more limestone, phosphate, and mixed fertilizer, and wider use of such practices as contouring, strip cropping, terracing, grass waterways, and tile and open-ditch drainage. It should be noted that these differences between the farms are continuing to widen.

For the 10 years, conservation cost on these farms averaged four percent of gross income compared with less than three percent for the low farms. The average cost, about $2.00 an acre, was about 50 percent above that for the low group.

In Madison-St. Clair counties, from 1939 to 1947, conservation practices brought similar benefits. The high-conservation farms fed slightly more feed per acre and had higher average returns per $100 worth of feed fed. Corn yields were about five bushels an acre higher. For the nine-year period net farm incomes averaged $5.60 an acre a year higher. There the annual costs for buildings and land improvements averaged $1.59 an acre higher on the high-conservation farms.

The high-conservation farms managed their entire farm business more successfully than the low farms, including the use of capital for conservation and for increased production. Soil fertility treatments and erosion control and pasture improvement practices produced more hay and pasture of higher feed value. The conservation farmers adjusted other parts of their business to make good use of the added hay and pasture. Their livestock returns were higher because they used the extra crops produced from the conservation plan.

In northwestern Illinois—Stephenson, JoDaviess, and Winnebago counties—from 1940 to 1947, 35 high-conservation farms had an average net income of $6.65 more per acre, or 31 percent more than 35 low-conservation farms.

Immediate Benefits from Conservation

Although long-time benefits from conservation farming are practically certain, the farmer is more interested in immediate returns. Often he is willing to use conservation practices only if he can see results more or less immediately. Such practices as contouring usually increase crop yield the first year because they hold the rainfall needed to produce high yields. Limestone. phosphate, and other fertilizers likewise have some effect on crops grown the year the fertilizers are applied. But the benefits from improved crop rotations generally do not show up until the grain crop harvested the year after legumes are plowed down.

During the three-year period 1945-47, 18 farms in McLean County (on which conservation plans were started in 1945 or since) produced grain equal in dollars-and-cents to that produced on comparable farms not following conservation plans. In addition they had over twice as large an acreage of legume hay and pasture and were building up their land for crop production in subsequent years. They also had lower total labor, power and machinery operating costs because of a smaller acreage of cash crops. These results show that even in the cash grain area conservation plans will yield dividends on a short-run basis.

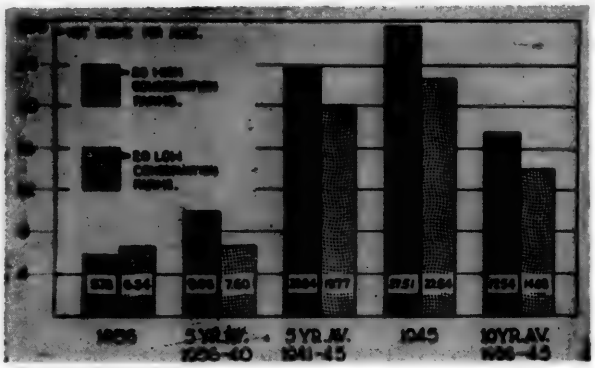

Figure 2. Increased yields accounted for an important part of the difference in earnings between the high and low conservation farms.

Capital Requirements for Conservation Farming

Capital expenditures for conservation and related improvements were analyzed on 100 farms located on slowly premeable soils in northeastern Illinois. For the years 1945-47 the average annual capital expenditures were $3,210, or $12 an acre. Of the $12 an acre, $1.65 was spent for land improvements, 96 cents for buildings, $5.85 for livestock, and $3.54 for machinery. Larger livestock purchases caused owner-operated farms to spend more than tenant-operated farms.

The farmers in this area were asked what their farms needed in order to develop a good conservation program. Standard costs were used to reduce estimates of materials to dollars and cents. These costs averaged $6,600, or approximately $24 an acre. They included needed applications of limestone and phosphate, drainage, and conservation structures, as well as livestock, buildings, and machinery needed to use increased quantities of roughages. The estimates included as many nonland improvement items (livestock, buildings, machinery) as land improvement. Estimated conservation needs averaged somewhat more on the tenant-operated farms than on the owner-operated farms.

The conservation plans worked out by soil conservation technicians and farm advisers with these farmers were then analyzed to determine the costs of establishing conservation programs in this area. The land improvements alone amounted to $23 an acre. The plans showed the need for much larger applications of limestone, phosphate, potash, and mixed fertilizers than the farmers estimated. The requirements outlined in the plans are based on soil tests and agricultural experiment station recommendations for maintaining a high level of production. The results in this area indicate that farmers tend to apply too little limestone and other mineral fertilizers to maintain the good stands and yields of legumes basic to any program of soil improvement and conservation.

The farmers thought they needed more tiling and other structures than was recommended by soil conservation technicians and farm advisers. The plans emphasized grass waterways, sod flumes, terraces, and open ditches. If the $12 an acre estimated to be needed for buildings, livestock, and machinery to implement a conservation program were added to the $23 for land improvements, the total cost of a conservation program would approximate $35 an acre, or $8,400 for a 240-acre farm.

Farmers and landowners will question the outlay of $35 an acre for conservation unless they sincerely believe it will pay. For the three years 1945-47, the annual income of 40 high-conservation farms in this area averaged $10.63 an acre more than that of 40 low-conservation farms. At the present high level of prices, the capital outlay for conservation could be repaid over a short period of years. Conservation costs vary, of course, from farm to farm and from area to area. All conservation expenditures do not need to be made at the same time or the same year. In all areas studied, however, conservation has proved to be a paying proposition over a period of years, although income may actually be reduced during the first year or so that a conservation system is adopted. Hence, unless the farmer has adequate capital resources to tide him over until he starts to reap benefits from a conservation program, he may find it difficult to start such a program except by spreading the improvements over a period of several years. Some farmers do not have enough money to start a conservation plan. On many owner-operated farms, the owner has to meet current payments on the land and does not have enough extra to make soil conservation improvements.

Figure 3. Erosion between corn rows planted up and down the slope on slowly-permeable Illinois soils.

Present loan terms of lenders are not adapted to advancing credit for soil conservation improvements. To allow for variations in rates of response from different soils and weather hazards, it should be possible to amortize loans for conservation purposes according to increased earnings from conservation over a period of at least five years. A good plan for conservation loans might be (1) prepare a budget to cover the whole conservation plan, (2) secure a mortgage loan commitment on a budget basis so the farmer can borrow as conservation expenditures are made and pay off the loan over a period of years from increased earnings, with interest charges only for the period the money is used.

Farmers should try to use their available capital in the wisest possible way. They should so invest it as to get the highest farm income over a long-time period and still keep soil productivity at a satisfactory level. In the past most farms have underinvested in land improvements, and some may have overinvested in machinery and buildings. The result is partial depletion of fertility—sometimes even irreparable erosion—and lower incomes.

Returns from land improvements are not realized as quickly as those from many other investments. But the fact that their incomes may not increase during the first two or three years of the conservation program should not deter farmers from making such investments. After this period the increased returns will usually more than justify the cost and the period of waiting. While repaying conservation loans, farmers are increasing their net worth by improving soil productivity and, hence, the productive value of their farms.

Reduced Incomes and Capital Losses from Nonconservation Farming

In a particular year the farm following a nonconservation type of farming may have the highest income. However, nonconservation farming removes plant food and will bring about progressively lower crop yields. This places responsibility on owners of rented land to take the initiative in soil improvement. The larger acreage of hay and pasture and soil-building legumes on the high-conservation farms results in less net removal of nitrogen than in the low group, even though more grain and hay are produced. Most of the high-conservation farms spend enough for limestone, phosphate, and other fertilizers to replace the elements removed by crops and to improve yields. The low group spends hardly half enough to balance crop removals and maintain fertility. Studies from experimental plots show that from 2 to 20 times as much plant food is removed by erosion as by crops. On rolling land, erosion will thus exact a toll. In figuring conservation costs on the high-conservation farms, it is only fair to consider the costs of loss of plant food and soil on the low-conservation farms.

Livestock and Conservation

More livestock may be needed on many farms to use the increased legumes and grasses resulting from a conservation program. Often farm operators, particularly cash-grain farmers, are reluctant to increase legume and grass acreages beyond a certain extent because they think a reduction in grain acreage means reduced income. On farms where grain acreages must be materially reduced in order to use land according to its capabilities, increases in crop yield may not offset reductions in acreages. But in most cases the increased returns from livestock bring higher net incomes. In addition, this system of farming helps to conserve soil and water and improve fertility. Modest improvements for livestock production may be a pertinent part of a conservation program.

In each area studied, the high-conservation farms had higher returns per $100 worth of feed fed and produced more pounds of milk and meat per acre than the low-conservation farms. In part, if not entirely, these higher returns and production were due to the larger quantities of better quality roughage produced. Higher crop yields reflect the effect of added minerals, legumes and grasses, and more manure. More livestock generally follows a greater production of hay and pasture, and most farmers tend to do more with livestock when they become an important part of the farm business.

Tenure and Conservation

In our studies the part-owner farms had the highest proportion of tillable land in corn and soybeans and the owner farms the lowest. But the owner farms had more tillable land in hay and pasture. The rented part of part-owner-operated farms is usually farmed harder than owner- or tenant-operated land. This point is too often

Figure 4. Beef cattle breeding herd on a mixed legume meadow on slowly-permeable soils of northeastern Illinois.

overlooked by owners who prefer to own unimproved land. Annual per acre expenditures for conservation, land improvements, and buildings were highest on owner-operated farms and lowest on tenant-operated farms. The largest total outlay for conservation was, however, on debt-free owner-operated farms and on tenant-operated farms where the landlord had adequate capital and both he and the tenant were sold on the program. The amount of livestock and livestock production per farm was considerably higher on the owner-operated farms than on the other two groups.

Tenure problems keep some landowners from adopting conservation practices. In areas with a high proportion of tenancy, how to divide increased costs and increased returns between landowner and tenant is a real problem. Another problem is how to use the increased quantities of roughage produced under a conservation plan. If livestock numbers are to be increased and grain acreages reduced on rented farms, livestock-share leases may have to replace some crop-share-cash leases. Both landlords and tenants might benefit from using a livestock-share lease. Certainly conservation practices are more readily adopted under such a lease and landlords are more willing to make needed building improvements. Livestock-share leases would give operators sufficient flexibility of operation to permit sound land-use programs. Longer term leases would also be desirable. Leases should include specific provision for compensating tenants who move for the remaining value of improvements they have made. Such a provision should make tenants more willing to invest in long-time improvements.

Summary

Our economic studies of conservation to date have not given us all of the answers to the problem. But they have pointed out significant relationships and have helped us to lay the groundwork for further studies in the field. From the standpoint of helping the individual farmer and the agricultural worker, we believe they point to the following significant facts:

The farms that scored highest in conservation practices followed a complete plan, including (1) testing and treating the soil, (2) using the land according to its capabilities, (3) using rotations with ample acreages of deep-rooted legumes, and (4) using proper water disposal practices, such as grass waterways, contouring, strip cropping, terracing, tile and open-ditch drainage where needed. These farms also tend to utilize forage crops through livestock.

Conservation plans do not necessarily increase earnings immediately, because considerable effort and money must usually be expended before positive results are achieved. The long-time benefits of conservation, however, are certain. Over a long-term period, conservation farms that have spent more money for soil and related improvements have more land in legumes and grasses, have higher crop yields, produce more and better quality hay and pasture, feed more livestock, have higher livestock production and returns, and secure larger net farm incomes.

In all comparisons the high-conservation farms had higher livestock efficiency as measured by "returns per $100 of feed fed." Does this fact reflect better livestock management or better feed? It can be argued, although our studies have not proved it, that better quality feed supplies—grain, hay, and pasture—explain the greater efficiency. In getting progress in agriculture—and conservation farming represents progress—it is important to get farmers to adopt systems which, in the hands of the average operator, lead to progress. Systems that conserve soil and water bring better crop yields, make the land easier to work, and apparently (although this is a tentative conclusion) provide better feed supplies, one of the fundamentals in more efficient livestock production.

Money spent on conservation is a sound investment. In addition to improving both present and future productivity, conservation practices usually increase the net income in one to four years, depending on the extent of needs. The returns provide a safe basis for establishing credit to put the conservation program into effect. Although the net income may be reduced temporarily, the productive value of the land increases immediately, protecting the financial position of the landowner until the long-time benefits of conservation can accrue. With our own as well as the world population increasing, investments in improving soil fertility, conserving soil and water, and controlling erosion should pay high dividends.

Figure 5. Soybeans on the contour on slowly-permeable soils in northeastern Illinois.

Recent Research Reviews

JAMES H. STALLINGS

The Reviews by J. H. Stallings that follow are a regular feature in the JOURNAL. It is hoped that the projects reviewed from time to time will be helpful to conservationists everywhere. Members of the Society are urged to indicate their interest in the kind of research work that should be reviewed.

Clay Mineral Models: Construction and Implication. *By* JOHN I. WEAR, JOE E. STECKEL, MAURICE FRIED, *and* JOE L. WHITE. *Soil Science, Vol. 66, No. 2, pp. 111-117. August 1948.*

Generally accepted atomic structures of the principal groups of clay minerals have been developed, although they are still being modified in detail. Clay mineral structure is basic to soil science. Many of the important properties of soils are influenced by it. These include exchange, release and fixation of ions, and physical structure of soils. In studying the physical and chemical properties of clay minerals as influenced by their atomic structures it is necessary to make use of visual aids such as diagrams and models. The use of schematic diagrams alone, however, is unsatisfactory, since most of those available do not show the so-called close-packing arrangement of atoms in the structures.

Since conclusions concerning nutrient release and fixation mechanisms in soils are often drawn on the basis of clay mineral structure, it is important to consider the implication of certain clay mineral structure concepts. The following concepts are not usually considered but are suggested by examination of clay mineral models:

1. So-called "close packing"
2. Number of sheets and layers involved
3. Actual size of atoms in the mineral.

The so-called "close packing" of the oxygen atoms is close packing along the c-axis only. The lower sheet of the tetrahedral layer is close packed only in the sense that each oxygen is in contact with four other oxygens, forming a complete hexagonal network. The other two sheets making up the kaolinite type mineral and the two center sheets of the four in the mica type mineral are not close packed, that is, the oxygens or hydroxyls are not in contact.

The second concept refers to the commonly used terms "1:1 lattice type" and "2:1 lattice type." This refers to the number of octahedral and tetrahedral layers, respectively. It is important to note that 1:1 type lattice actually consists of three sheets of oxygens or hydroxyls and the 2:1 type lattice actually consists of four sheets of oxygens or hydroxyls.

The third concept probably has the most bearing on studies of the mechanism of fixation. Attempts to build models to scale showed that the cations may not be the correct size to fit into the compact structures. For example, considering the radii for oxygen as 1.40 A and silicon 0.41 A, the silicon atom would be too large to fit into the center of a compact tetrahedron made up of for oxygens. This implies that either the force field representing atomic size is not spherical or that the ion involved does not have the same size in the clay mineral as it had in the compound in which its size was determined. The latter conclusion is not unreasonable, since the so-called size of an atom is affected by many factors, among which are the nature of the complementary ion, the type of valency, and in general the nature of the environment in which it exists. For example, an aluminum ion in the so-called tetrahedral layer does not have the same size when it is present in the octahedral layer. The Al-- distance in many octahedral layers is close to 1.90 A; in many tetrahedral layers the Al-- distance is in the neighborhood of 1.66-1.76 A.

The smallest diameter in the hexagonal holes in the silica sheet is 2.6 A. The potassium ions are fixed in these holes in the phenomenon of potassium fixation, the commonly considered diameter of the potassium ion being 2.66 A. Rubidium can also be fixed by clays; yet the rubidium ion has a diameter of 2.96 A. This would suggest that these ions could fit only partially into these holes. It is believed that this may occur. Since this comparison is based on independently determined cationic sizes and anion-to-anion distances, the comparison may not be valid. **The hole that is 2.6 A in diameter with respect to the oxygen atom may not be the same size with respect to potassium or any other ion.** In general, the smaller the unoccupied space or pore, the greater the percentage uncertainty as to its exact size.

The difference in the size of an ion in different compounds is a danger signal to the investigator who attempts to determine spacings by adding up ionic sizes.

Porous Plate Apparatus for Measuring Moisture Retention and Transmission of Soil. *By* L. A. RICHARDS. *Soil Science, Vol. 66, No. 2, pp. 105-110. August 1948.*

The author describes an improved method for mounting and using porous plates for measuring the relation between soil moisture tension and the moisture content of the soil. The apparatus is particularly adapted for

making moisture-retention determination on large numbers of samples. It can be used also for measuring the permeability of soils at moisture contents below saturation.

The Influence of Top Growth Removal on the Root and Vegetative Development of Biennial Sweetclover. *By* DALE SMITH *and* L. E. GRABER. *Jour. Am. Soc. Agron., Vol. 40, No. 9, pp. 730-743. October 1948.*

The responses of Madrid sweetclover following removal of the top growth at various dates during the first season were studied. The amounts of root and top growth, the development of coronal rhizomes, the carbohydrates in the roots, and the nitrogen content of both roots and tops were determined.

Removal of top growth in mid-September markedly reduced the dry weight of the roots, the amount of readily available carbohydrates and total nitrogen in the roots, and the size of the coronal rhizomes and caused buds on many coronal rhizomes to elongate into green leafy shoots before winter of the first season. The number of coronal rhizomes per plant by the end of the first season was not materially affected, but the size was reduced. Cuttings on August 16, September 2, and October 18 affected the subsequent growth of sweetclover plants to a lesser degree but in a similar manner.

The yields of top growth in the second year were directly correlated with the amounts of carbohydrate and nitrogenous food stored in the roots by winter of the first season under the respective treatments. Reduction of top growth were accompanied by similar reductions in the amount of total nitrogen in the tops. From the standpoint of carbohydrate foods, it appears that the top growth of biennial sweetclover becomes self-sufficing, for the most part, during the period of its greatest expansion in the second year.

Diversity of Amino Acids in Legumes According to the Soil Fertility. *By* V. L. SHELDON, WM. G. BLUE *and* WM. A. ALBRECHT. *Science, Vol. 108, No. 2808, pp. 426,428. pp. 426-428.*

Agriculture is concerned with the synthesis of food. While watching the delivery of bulk, we have kept up the synthesis of caloric compounds by plants, but much of their capacity to synthesize proteins has been lost. For these latter, or body-building, substances, more than good weather is necessary; plants, like animals, can be said to be, and to behave, only according as they are nourished via the soil. Of the many requirements of any diet, protein presents itself for first consideration. The major problem in the production of healthy animals, is one of obtaining sufficient protein of the quality commensurate with nutritional demands. The biosynthesis of the building stones of the body, namely amino acids, making up the proteins must be considered as well as the photosynthesis of the carbohydrates composing the plant bulk. Many nutritional problems are traceable to the effects of the ash constituents coming via the plant. Biosynthesis requires these inorganic elements, not only to catalyze various reactions within the plant, but also to fashion and to build its structure. In turn, animals depend on the plants to synthesize the protein constituents for them. Herein lies the vital function of the soil. There is a wide variation in concentrations of amino acids in plants because of (a) differences in the crops and (b) differences in the fertility of the soils.

Our Forests and Watersheds. *By* EDWARD N. MUNNS *The. Scientific Monthly. Vol. 67, No. 5, pp. 347-354. November 1948.*

The author discusses research studies being conducted at the Coweeta Experimental Forest near Franklin, North Carolina. Much information has been gained about basic hydrology, particularly a more realistic interpretation of forest and stream-flow relations in terms of watershed storage. In humid climates the precipitation recharge for any one year should tend to equal the discharge from the watershed in the form of runoff, transpiration, and evaporation, together with the changes in soil moisture and ground-water storage. Any disturbance to the soil will change the watershed picture. A dense forest of a type that uses a great deal of water may be highly desirable for flood control purposes. The litter and humus permit maximum infiltration in the soil, and during the growing season the forest tends to use up a large part of the precipitation that comes in the form of heavy storms. By drying out the soil, the forest provides storage space for subsequent storms so that the soil goes into winter relatively dry.

The Dust Storms of 1948. *By* H. H. FINNELL. *Scientific American Vol. 179, No. 2, pp. 7-11. August 1948.*

On the gray prairies of the Southwest, the dust is blowing again. Over wide stretches of New Mexico and west Texas the ominous signs are plainly written. Drifts of soil lie banked across the roads, and yellow clouds have begun to rise from the naked land. The specter of a new dust bowl haunts the Great Plains. It has developed rapidly, but not unexpectedly, within the past few months. Three years ago there was only one dust storm. Last year 3 big dust storms sprang up in the cotton, sorghum and bean area of Texas and New Mexico. This year, in the blow season from January to May, there were 17. Of the 3.5 million acres of farming land darkened by the storms, more than a fifth was heavily damaged.

The major cause of the new menace is the great wartime plow-up of marginal soils. Much of the land that

has now begun to blow has been broken out since 1941. After two or three crops these soils begin to break down. This year's outbreak of dust storms was a harvest of the quick decline of stability in the sandy soils.

This new cycle of dust need not be permitted to blow itself out. With scientific control it can be stopped. If the soil is not exposed the wind cannot raise the dust. Land can be kept in cultivation even in the high-hazard areas of wind erosion—provided only that a cover of vegetation be maintained continuously on the soil. The ideal way is to use the residues of productive crops, leaving a stubble mulch of stalks and straw to tide over the soil from one crop to another. The straw from one good wheat crop will hold the soil through the blow season for two years, if it is well managed.

Evaluating Soil Losses from Field Areas. *By* D. D. SMITH *and* D. M. WHITT. *Agr. Eng., Vol. 29, No. 9, pp. 394-396 and 398. September 1948.*

A rational erosion equation is presented by which probable soil losses from field areas can be calculated. The method of calculating field soil loss is termed the factor system. The approach is rational and not theoretical. Cropping systems, land slope, soil, rainfall, and supporting conservation practices are the principal factors used in developing the equation.

The Effect of Spillway Storage on the Design of Upstream Reservoirs. *By* M. M. CULP. *Agr. Eng., Vol. 79, No. 8, pp. 344-346. August* 1948.

The author contends a rational approach to designing dams and spillways requires that as many as possible of numerous variables involved be identified clearly, isolated, and adequately treated in the engineering analysis. The effect of temporary spillway storage can be completely and accurately computed for any given flood, reservoir site, and spillway discharge characteristics. A number of the problems involved are discussed and illustrated.

A New Approach to Erosion Control. *By* GROVER F. BROWN *and* WALTER D. ELLISON. *What's New in Crops and Soils, Vol. 1, No. 1, pp. 12-13, and 24. October 1948.*

New understanding about the mechanics of soil erosion point the way to new methods for measuring erosion on the land. New "measuring sticks" are now available for determining the effect of different crops and soil management practices in checking soil erosion losses.

Two distinctly different types of soil erosion are produced by rainfall on the land surface. One of these is caused by the splash of raindrops and is called *splash erosion.* The other is caused by the scouring action of water flowing over the field and is called *scour erosion.* Two steps are involved in eroding the land by each of these types of erosion. They are detachment and transportation.

Splash erosion is a land-leveling process and scour erosion is a land-carving process. Splash erosion and scour erosion must be measured seperately. Each affects the land differently and each requires different types of control.

The Role of Commercial Fertilizer in Soil Conservation. *By* RALPH W. CUMMINGS. *Agron. Notes, No. 8, October 6, 1948. National Fertilizer Assoc., Washington, D. C.*

An adequate program of soil conservation must provide for the maintenance of a permanent and *productive* agriculture and for the passing of soils from one generation to another in at least as high if not higher state of productivity than that in which they were received. A permanent system of agriculture, providing for adequate soil conservation, is not a reality on many farms of the Piedmont Plateau and Appalachian mountain areas despite heavy use of commercial fertilizer. This is because of the fact that the right combination of crop selection, soil management, and fertilization has not been put into effect. Reclamation of much of this eroded land is dependent on the use of fertilizers and lime. Results from experiments carried out on a small watershed consisting of 11 acres of severely eroded, abandoned crop land are presented to support this claim.

Pictorial Report of the Erosion Problem Under Furrow Irrigation in the Lower Yakima Valley of Washington. *By* STEPHEN J. MECH. *USDA.SCS, Prosser, Washington, Typed May 14, 1948.*

Erosion under irrigation is becoming recognized as one of the greatest hazards to the permanency of irrigated agriculture. This report is an effort to present some phases of the erosion problem quickly and effectively with a minimum of text and data. Much erosion occurs on the upper end of irrigated fields even when there is neither runoff nor soil loss from the field itself. Vegetation is either absent or if present is removed and destroyed in developing the furrow. Increased infiltration under furrow irrigation requires a greater irrigating head regardless of whether the flow is absorbed by a high infiltration and short run or a low infiltration and long run.

People Sense Reality

"The people . . . sense reality better than those whom they elect to represent them. The rank and file are soon lost when questions become all technical but when broad policies are put before them the polls support that profound warning by the late Raymond Clapper: "Never overestimate the people's knowledge, nor underestimate their intelligence"—STUART CHASE IN "THE PROPER STUDY OF MANKIND."

BOOK REVIEWS

***GRASS:** The Yearbook of Agriculture, Edited by* ALFRED STEFFERUD. *Supt. of Documents. Washington, D. C. 1948. 892 pp., illus. $2.00.*

With the 1948 issue, the Yearbook of Agriculture returns to the prewar plan of devoting an entire volume to a comprehensive symposium of some major topic of importance to agriculture.

The topic is well chosen, and the book does an impressive job of emphasizng it. The time was opportune for focusing attention upon the role of grass. This is done effectively, both in relation to crop-land farming and to the economy of the western ranges. Grass is duly recognized for its part in the amenities of life, too, in parks, and lawns, and fairways. A more thorough job could hardly have been asked.

No recent government publication has been heralded with more advance publicity. The press associations and the feature writers gave it good notices. Such national magazines as the *Country Gentleman* devoted lead articles to reviewing its contents. Congressmen were receiving requests for "the new grass book" before it was released for distribution.

All this was good in bringing grass into the public consciousness as a vital and major factor in our present-day economy and in the conservation of our soil resources for the future. But when it arrived, many discriminating readers in the field of grass management pored through the new book with misgivings.

The first uncertain report came to me from a source I regard highly—from the grass roots themselves. A rancher friend approached me even before I had received my copy of the new Yearbook. He said, "What do you think of that new grass book Congressman Blank sent out?"

I had to confess I had not seen it, but asked his opinion.

"Well, I don't know," he said cautiously; "it contradicts itself. I read along and it says one thing, then I read some more and it says something else."

This, from a practical rancher, who reads thoughtfully if not widely, was a criticism true to the mark.

Shortly afterward I had the curious experience of reading the Yearbook at the same time that I was reviewing some of the first bulletins on the Western range published by the Bureau of Plant Industry. At times it was difficult to keep in mind just which volume I had in hand at the moment—so little difference was there between some of the earliest, and the very latest, writings of the Department on range management. The same problems—of overuse, of systems of grazing, of reseeding—were being discussed in essentially the same terms.

Actually, there have been great strides in range management technology since the beginning of the century. Illuminating principles of ecology have been discovered and put to work in stirring fashion in analysing practical range problems and prescribing effective treatments.

That the Yearbook of Agriculture should contain only a pale reflection of these modern concepts, and should be criticised as contradictory, is a result of the plan of writing. First, the subject matter was broken down into rather artificial categories. Then, a representative of each of several agencies was asked to collaborate on the article. With authors of such widely divergent experience and viewpoints, and all governed by the ingrained cautiousness of the Department, at work on the same manuscript, the result was generally innocuous. By the time all the points to which any one of the collaborators took exception had been deleted, only the old established ideas remained.

The independent treatment of essentially the same topics for each of the geographic regions of the country could lead only to duplication, and, frequently, to contradiction.

The agronomic phases of the subject generally fared better. The newly recognized role of grassland farming is well presented. The procedures recommended for establishing and managing tame pastures, cover crops, and soil-building rotations are adequate, judging from the treatment of regions with which I am familiar.

The section on "grass in charts and tables" is unique and priceless. Nowhere else is so much exact information about grass and legume seeds, their characteristics, uses, planting requirements, and other related technical data, assembled in one place. This section alone will justify the book to the technician and farmer alike.

The editorial craftmanship, like that of the preceeding Yearbooks, is of the highest order. The typography is pleasing, and the material is attractively illustrated. For the first time, color photographs are used—and generously.

By the sheer weight and importance of its subject matter, this book will take its place as an impressive addition to the Yearbook series. Whatever specialized technicians may see in it, it will carry to the general public and to agricultural workers the story of grass as it has

never been told before. After all, this is probably the primary function of a Yearbook of Agriculture.

—BEN OSBORN, *San Angelo, Texas.*

MINERAL NUTRITION OF PLANTS AND ANIMALS. *By* FRANK A. GILBERT. *University of Oklahoma Press, Norman. 1948. Pp. 131, figs. 31. Price, $2.75.*

Widespread interest in the mineral composition of plants in relation to the well being of animals and man assures this book of a wide reading. The author is associated with Battelle Memorial Institute at Columbus, Ohio, where he is a member of the agricultural sciences research division. Much of the data in the book was accumulated in the course of research on the effect of trace elements on plant nutrition. Although phosphorus, calcium, magnesium, and potassium relationships are considered in some detail, the more interesting part of the book is that dealing with sulfur, iron, copper, cobalt, manganese, zinc, iodine, boron, molybdenum, aluminum, silicon, sodium, chlorine, fluorine, arsenic, lead, and selenium. The primary criticism that might be made of the discussions of these elements is that they are much too abridged. Nevertheless, the appended list of references includes 329 titles of important books and papers. The illustrations are excellent and well chosen. The book might well be used as a starting point for reading on the part of those who are unfamiliar with the work in this field of research.

—FIRMAN E. BEAR, *New Brunswick, N. J.*

PLOWSHARES INTO SWORDS. *By* ARTHUR P. CHEW. *Harper & Brothers. New York. 1948. 277 pp. $3.00.*

In this book the author develops an economic theory as the cause of wars. The basic struggle between industry and agriculture is at the root of most of the world's armed conflicts. This struggle takes place between nations and within individual nations. Chew points out that there must be a balance between factory output and agricultural output. Factories must have agriculture from which to draw raw materials and food supplies, and as a market for finished products. Agriculture depends on industry for its operational machinery and for markets. When these two are in balance, particularly between nations, there is little cause for armed conflict. Chew points out, however, that industrial nations, which are normally in a much better position than agricultural nations to wage aggressive war, must have sufficient agricultural resources for their needs. If they do not have them, two choices are open: (1) They may obtain the needed resources by force of arms, or (2) they may develop trade with agricultutal nations.

Chew points out that the superficial explanation of some wars is presented to the people as ideological. This was shown clearly in the last world war when the differences in the ideologies of fascism, communism, nazism, and democracies were emphasized. To increase the interest in a war, leaders often resort to personification. Thus, we saw Hitler, Mussolini, and Hirohito on one side, and various more admirable leaders on the other side. The appeal here was for layman unfamiliar with the basic issue of industry versus agriculture. Chew points out that the balance between industry and agriculture must be achieved throughout the world or war will surely recur. His solution is where he has difficulty. He does point out clearly, however, that there must be more freedom of world trade.

Imports, exports, and price adjustments get some attention. The author's thought concerning two prices for products, one local and one export, is not new, but he manages to marshal a great deal of logic for this system. Surplus goods must be placed on the world market at a price that market can afford. I particularly liked the chapter on conservation and trade practices.

The Book has many stimulating ideas, and even though it is hard to read in spots and difficult to understand, particularly if you are not an economist, it is well worth one's time and effort. Chapter 4, where the early philosophies of Veblen are compared with his later ones, seems to me a bit beside the point. Not knowing who Veblen was in the first place, I find it confusing and of small interest.

I can recommend "Plowshares into Swords" to anyone interested in agriculture, and particularly to those who are concerned with agriculture's part in maintaining world peace

—GROVER F. BROWN, *Washington, D. C.*

THE PROPER STUDY OF MANKIND. *By* STUART CHASE. *Harper, N. Y. 1948. 311 pp. $3.50.*

Under the sub-title "An Inquiry into Human Relations," Stuart Chase summarizes much that has been learned by sociologists on the subject of how people can get on together, and why. Although most of the experimental work has been done in industry, the soil conservationist will find the results reported to be of interest in his own dealings with others.

POPULATION ANALYSIS. *By* T. LYNN SMITH. *McGraw-Hill, N. Y. 1948. 421 pp. $4.50*

Here is a book for those who are finding it necessary to know something more about populations, especially techniques by which demographic data are obtained.

It deals with composition and growth of population, vital processes and migration. The student of the population-resource relationship will want to examine this volume.

Characteristics of Forest Soils

(*Continued from page* 12)

The principal mapping unit of the conventional soil survey is the soil type (series and texture), with which is included, usually, slope and degree of erosion and a limited recognition of stoniness.

As soil type separations are based on morphology rather than use, types with similar timber-growing qualities may be grouped for forestry purposes. Under certain conditions survival or growth has been found to correlate reasonably well with one or two specific soil properties such as texture and thickness of the A horizon, or depth to the C horizon, etc.

Other soil-site factors which influence site and which, therefore, should be included in the forest soil legend are: slope and aspect, moisture relations, humus type, and a more complete breakdown of stoniness than formerly used.

Detailed mapping of forest land is seldom justified, while over-generalization may be of little value. A happy medium is the answer. Forest type maps should be accompanied by soil maps of at least equal detail.

The mapping legend devised for Connecticut is described.

The mapping of soil characteristics significant in tree growth and stand composition is practicable and not unnecessarily difficult. The chief requirement is the addition of certain soil-site factors not ordinarily recognized, to the conventional map legend, and a limited amount of generalization of soil types. Detailed soil maps may be more useful in forestry if soil types having similar characteristics are grouped.

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Instructions to Authors

The JOURNAL seeks to publish only material that relates to soil and water conservation and land use. Original contributions are preferred. Papers may deal with ideas, techniques or procedures. They may be discursive, controversial or philosophical. They must be as concise as the subject permits, well organized, and clearly written. The style should be forthright and factual, not conservational or reportorial. The subjects treated should be of interest to professional soil conservationists, in the broad sense.

Material: The type of material accepted may be: (1) Scientific articles presenting original research in soil conservation; (2) technical articles presenting applied aspects of soil conservation; (3) general articles relating soil conservation to human welfare, economics, politics, culture, and various aspects of modern living; (4) reviews of books and other publications; (5) comments and communications; (6) discussion and debate; (7) photographs of land use or land depletion; and (8) miscellaneous fillers, etc.

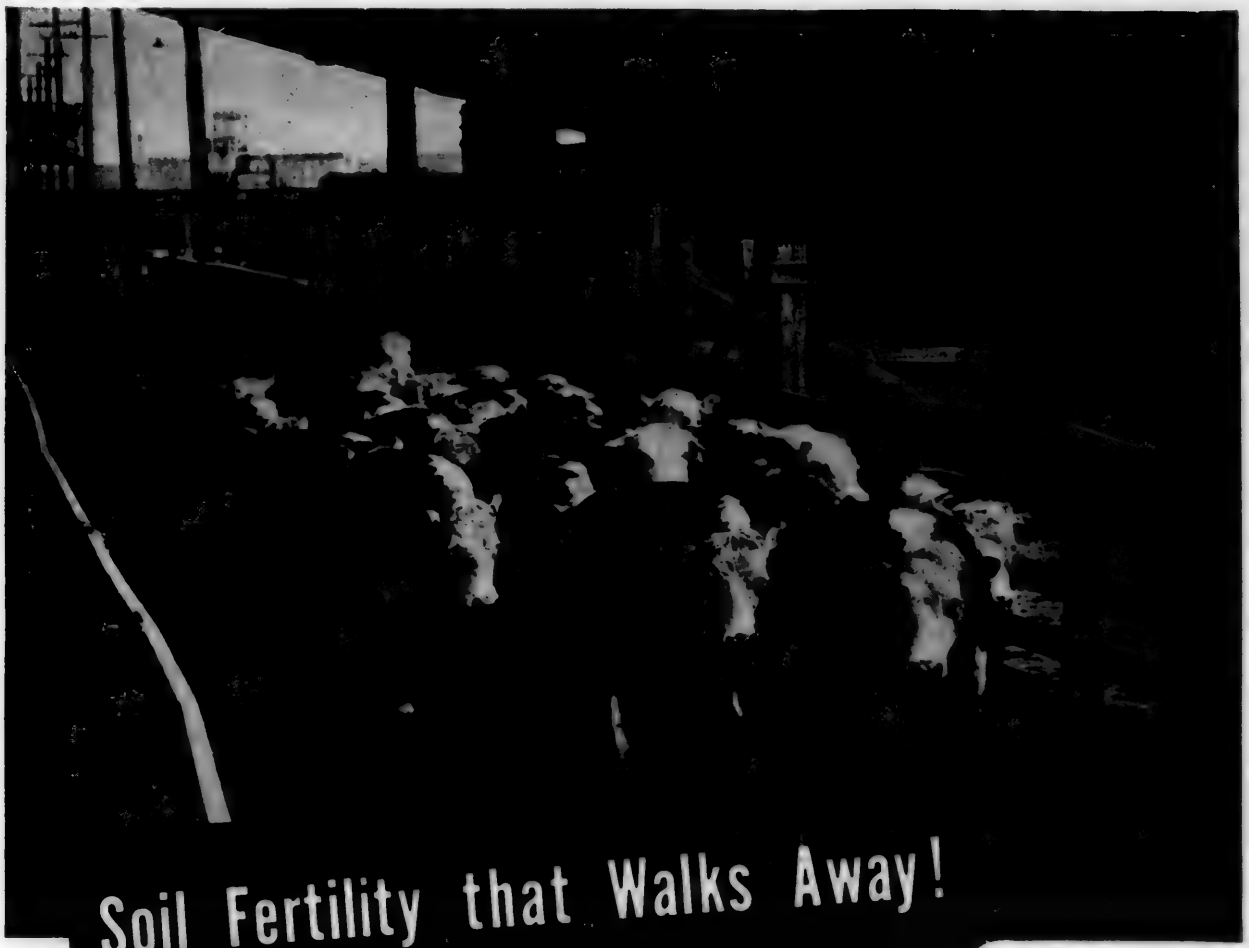
Copy: Manuscripts must be submitted typed on hard copy, double spaced, with ample margins. Carbon copies will not be accepted without the hard copy. One carbon should accompany the original.

Photographs: Illustrations may be photographic or drawings in jet black ink on white paper. Lettering must be neat and large enough to take some reduction. Photographs must be glossy prints, preferrably 8" x 10" or as near that size as possible, in focus, contrasty, and selected to illustrate specifically the subjects treated. Legends should be brief. Each illustration should be referred to in the text. Cite each illustration by Figure number.

References: Literature may be cited in an article by number in parentheses. Numbers should refer to a list of references at the end of the paper, with references listed alphabetically. Cite only those papers listed in the Literature Cited, and be sure all references in the Literature Cited are referred to specifically. Do not cite mimeographed or processed material if it can be avoided. If cited, it should be indicated as mimeographed or processed. Don't vaguely refer to a piece of research by so and so without exact reference in the paper and literature cited.

Sub-headings: Use of sub-headings throughout the text helps the reader materially. A summary is highly desirable. Tabular material can be used if neatly and clearly presented. Cite each table by Table number.

Scope: Papers treating some special aspect of agronomy, soil science, forestry, education or any other subject *without* a definite relationship, direct or implied, to land use or soil and water conservation, will not be accepted.



Soil Fertility that Walks Away!

Most of our actual soil wastage is in the form of soil erosion. Soil assets are wasted because they get completely away from us. They pile up in the streams, in lake beds, and out on the bottom of the seas.

On the other hand, a lot of soil fertility walks off the farm—in the bodies of cattle, hogs and sheep. It also goes in milk cans, butter tubs, fruit baskets, egg crates and tin cans. It goes as carloads of wheat, bales of cotton, bags of wool, and frozen foods; as countless billions of tons of proteins, carbohydrates, fats; as cellulose and naval stores; as immeasurable tons of farm products containing all the minerals that compose a fertile soil.

In those numerous and useful forms, soil fertility usually is not wasted. The farm products are sold for use, and good use—the sustenance of human life. But those products still represent just so much *soil productivity*. If the land from whence the products came is to remain productive, it's got to have more than "a lick and a promise." An occasional load of manure or a haphazard seeding of alfalfa now and then won't maintain soil fertility.

When virtually every farm is operated under a complete plan or system that improves, or at least maintains, its state of productivity—then we will be holding our own *on the land*. Far from being impossible, that is the goal we — as a nation — are shooting at. Now nicely started, we still have a long way to go.

John Deere

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FIELD NOTES AND COMMENTS

Time Article Misleading

Late last November, *Time* magazine published an article entitled "Eat Hearty." It contained many statements that were misleading and confusing. Because of the implications involved, a resolution calling attention to the inaccuracies was approved by the *Society* at the Cincinnati Meeting. The resolution and *Time's* reply follow.

WHEREAS the *Soil Conservation Society of America* believes that people should be accurately informed of the condition of our soil and water resources and properly appraised of the relation of the conservation of these resources to the general welfare;

BE IT RESOLVED that the following letter be sent to the Editor of *Time* Magazine:

Dear Sir:

The *Soil Conservation Society of America*, an organization of professional soil conservationists, is in disagreement with many of the statements made in the article headed "Eat Hearty," *Time*, November 8, 1948.

It is the opinion of the Society, expressed in resolution at its Annual National Meeting at Cincinnati, Ohio, December 9-11, 1948, that the reporting in this article is inaccurate and misleading, that the full facts are not presented, and that the facts presented are treated in highly selected fashion.

By tending to create a feeling of complacency with respect to the nature and condition of the natural resources upon which we all depend, *Time* has done a major disservice to the people.

T. S. BUIE, *President*

To this Time replied:

Dear Mr. Buie.

The resolution by the *Soil Conservation Society of America* regarding the International article "Eat Hearty" has been read with interest by the editors. It was certainly not *Time's* purpose, however, to discourage soil conservation practices and we do not believe the article in question should have that effect. We pointed out that "soil mining and erosion are still causing inestimable damage" but equally important news is the fact that "U. S. soils are now getting better, on the whole; the downward trend has been reversed."

Service to the public motivated our report, a service of providing information. Despite the Society's resolution, we continue to feel that a service was performed.

RVTHVEN TREMAIN—*For the Editors*

Land Policy Statement Well Received

Dear President Partain:

Our Board of Supervisors studied the Associated Press release on the National Land Policy Statement drafted by the *Soil Conservation Society of America* at its recent convention in Cincinnati. Our Board unanimously indorsed this program, and asked me to notify the Society of our action and to pledge you our support and cooperation in getting the program adopted and in operation.

PAUL PEYTON, *Secretary, Hopkins County Soil Conservation District, Madisonville, Kentucky*

This is one of several letters received by the President regarding the Society's Land Policy statement.—EDITOR.

Range Management Society Grows

Half the land area in the United States is used for the grazing of domestic livestock. Despite this, until recently, there has been no professional society with a primary interest in the conservation and use of this vast and important part of our natural resources. Two years ago, the American Society of Range Management was formed to fill this long-felt need. Two annual meetings have been held, the first at Salt Lake City, Utah, in 1948, where 200 range men, most of them from the west, gathered to perfect their organization, elect officers, and adopt a constitution. During the past year, the Society has grown to 800 members and expects to double its present membership in 1949. Present members come from 30 states, Alaska, Hawaii, and from three foreign countries. They represent nearly a dozen federal agencies concerned with management of grazing land, chief among them such important conservation agencies as the Forest Service, the Soil Conservation Service, and the Bureau of Land Management. Many biologists, big game specialists, and others interested in the preservation and management of wildlife and of "wild lands" have joined the Society. There are also members from the state extension services, and heads of the range and conservation departments of the leading educational institutions teaching these subjects. Finally—and unique in this respect among professional organizations of this kind—the Society numbers among its members many of the real professionals in this field, leading ranchers who earn their living in the production of livestock and in the management of grazing land. A quarterly "Journal of Range Management" has been launched, three issues of which have already appeared.

In All Three 1948 National Plowing Matches the Champions Chose..

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CHAMPION Ground Grips

IT TAKES perfect tractor tire performance to win a national plowing match. The top-notch plowmen in this country have learned that through experience. That's why the winners in all three national matches at Big Rock and Wheatland, Illinois; and Dexter, Iowa chose Firestone Champion Ground Grip Tractor Tires.

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This combination of *Firestone Champion Ground Grip Tractor Tires with their full traction bite—Firestone Hydro-Flation*—and *exactly 12 pounds pressure* will give you championship performance just as it did the winners in the national plowing matches.

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First in Prize Winners Class
Big Rock, Illinois Match

LLOYD EIPERS
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Wheatland, Illinois Match

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First in Level Land Class, Dexter, Iowa Match
First in Gold Medal Class, Big Rock, Illinois

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Progress is Reflected in President's 1948 Report Given at Cincinnati Meeting

President Musser, at the Second Annual Meeting of the Society held in Omaha a year ago, established a most worthy precedent in limiting his presidential address to a few essential remarks. I have no intention of deviating from this precedent and I shall not engage in a long discussion of soil conservation and the detailed workings of the Society. However, I do feel that the outstanding accomplishments of the year should be brought to the attention of the membership.

Modern science differs in many ways from alchemy, its medieval counterpart. Not the least among these differences is in the dissemination of acquired or attained knowledge. Had the alchemist of old been successful in his search for the formula to transmute a base metal into gold, his secret would have been guarded with his life.

Not so with the scientist of the 20th Century. When in his search for further insight into nature's processes, a new truth is encountered, one of his first thoughts is to make this discovery known to his associates that they may confirm or deny his findings.

One of the media for disseminating such newly acquired knowledge is the professional society. In annual and other meetings, through publications, and otherwise, an opportunity is provided for acquainting the entire membership with the developments in a particular field.

It is particularly fitting that soil conservation, a new science, should have an organization to render this service to those interested in this particular field of endeavor. Many of the older professions, representing branches of science long established, are highly organized. Certain groups, such as physicians and theologians, begin even in their college days to associate themselves together. Soil conservationists on the other hand have been recruited from various fields. As is to be expected in a newly developed and recognized science embracing agronomy, engineering, soils, biology, forestry, and other specialized fields, there is need for cohesion. It is fitting that agronomists, engineers, foresters, and other specialists should engage in the science of soil conservation and it is also appropriate that they have a common meeting ground and a common approach to their problems. This is furnished through the Soil Conservation Society of America.

Although one of the newer technical societies, we have developed remarkably fast. Few professional societies, regardless of age, can boast of as large and representative membership as ours. In 1948, there were 2,476 individuals throughout the United States, and 125 in foreign countries, who were paid up members. In addition, there were 65 libraries and other agencies subscribing to the JOURNAL, or a grand total of 2,666 paid up memberships, a gain of 307 during 1948. Also, there were in December 1,880 members who had paid their 1949 dues, thus indicating an excellent start on the new year.

The Society was represented at the conference on Land Use policy at Omaha in May, and at the Inter-American Conference at Denver in September. Also, an invitation has been accepted by your President to present a paper on Physical Methods of Soil Conservation at the United Nations Scientific Conference on the Conservation and Utilization of Resources to be held in this country in May or June 1949.

I am happy to report, also, that your Secretary has been notified that the Soil Conservation Society of America has been admitted as an associated society of the American Association for the Advancement of Science.

The financial status of the Society, as reflected in the treasurer's report, is excellent. The anticipated income for the year will substantially exceed the contemplated expenditures, resulting in a sizeable sum to be added to the cash balance and reserve, which at the beginning of the year was $9,360.87.

The work of the several committees has been excellent and most encouraging. The members of these committees have wholeheartedly responded to all calls made by the respective chairmen and Society officers. Particularly noteworthy of the work of the regular committees is the preparation of a glossary of conservation terms by the Glossary Committee, and the preparation of a statement on National Land Policy by the Organization and Policy Committee.

At this time there are 29 organized chapters, representing an increase of three for the year. The work of many of these groups is encouraging and in some cases outstanding. Through such chapters opportunity is afforded for those who are interested in the science of soil and water conservation to come together for a discussion of problems of common and local interest.

Your president was fortunate to be able to attend meetings of three chapters during the year. One of these, the annual two-day meeting of the West Virginia Chapter held at Jackson's Mill, was outstanding. There were approximately 85 members present and the discussions were of high quality. Interesting meetings and worthwhile activity programs of other chapters have been reported to the membership through the News.

—T. S. BUIE, *Spartanburg, South Carolina.*

History Re-Lived

5000 Years of Farming

THE STRUGGLE FOR FOOD—FROM SCARCITY TO ABUNDANCE—IN TWO VISUAL PRESENTATIONS

A SOUND SLIDE FILM

5000 Years in 50 SCENES

TIME: 20 MINUTES

Here, in 35 mm. film strip supported by a record with narration, music, and sound effects, is the story of plowing and of threshing through the ages. In it, you will see the cave-men with crooked sticks, Egyptian oxen, the colonial plow, and the steel moldboard which founded an industry. Likewise, the story of threshing is told, from the 1830's to the present day. For any group interested in farming and its history, here is entertainment and education of the highest type.

A 16 MM. MOTION PICTURE

PAGEANT of PROGRESS

TIME: 22 MINUTES

In this full-color motion picture, sight and sound are combined to present in action the history-making plows, threshers, and tractors of the past. Here you can see the old steam traction engines at work, and hear their whistles. Here, as in the Wisconsin Centennial pageant where most of the scenes were taken, you will see characters in costume, and historic machines handling real grain. To schedule an early showing of either film write nearest branch. J. I. Case Co., Racine, Wis.

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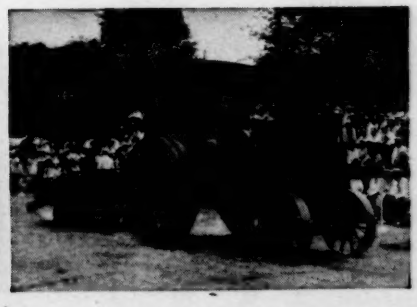
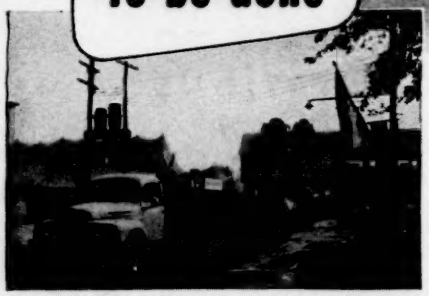


there's a **JOB** to be done

Here's How KENTUCKY *Is Doing It*



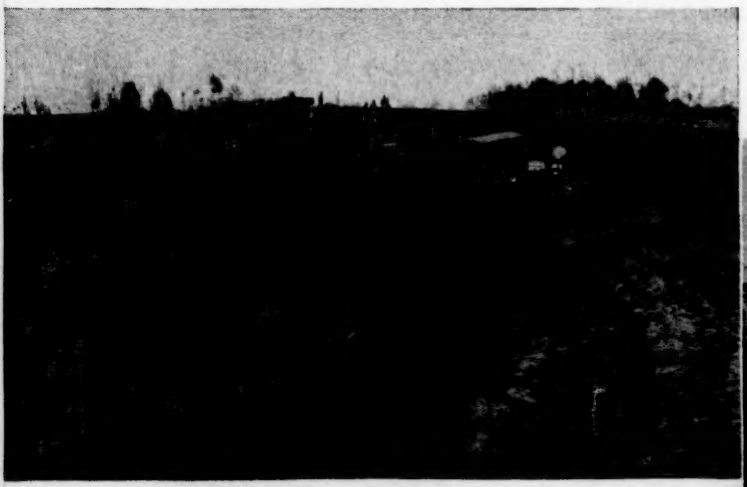
In the Caravan as it left the State Fairgrounds at Louisville, were farm tractors with disc plows, crawler tractors with root rakes, power graders and many other pieces of equipment.

A view of the H. M. Fannin farm at Ezell, Morgan County, with some of the terraces and diversion ditches in the foreground.

Sponsored by the Kentucky Association of Soil Conservation District Supervisors and with the cooperation of the U. S. Soil Conservation Service, Kentucky Division of Soil and Water Resources, State Extension Service, State Division of Vocational Agriculture, and many other state and local groups, a Conservation Caravan toured the state during the month of October making twelve stops and holding twelve Conservation Field Days, at each of which an interested audience saw a complete demonstration of the latest types of equipment carrying out the latest soil and water conservation practices.

The touring caravan idea was a complete success. Each piece of equipment—from the smallest to the largest—had its part to play, and played it well.

AUSTIN-WESTERN COMPANY • AURORA, ILLINOIS, U. S. A.



The Austin-Western "99-H" Power Grader built this diversion ditch on the Richard Steele farm at Winchester, Clark County.

The bulldozer attachment can be used very effectively for filling low spots and cutting off high spots, and for clearing brush and other clean-up operations—thanks to exclusive All-Wheel Drive and All-Wheel Steer.

BUILDERS OF ROAD MACHINERY

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